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The Mining Magazine

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EDITORIAL

OUR Melbourne correspondent has frequently emphasized the importance of a major oil discovery to the Australian economy. Of the most favourable areas for finding oil in the sub-continent the Fitzroy Basin is considered the most important, so that the publication of Bulletin No. 36 by the Commonwealth Bureau of Mineral Resources, entitled " The Geology of the Fitzroy Basin, Western Australia " can the more eagerly be welcomed. This report, the compilation of which was seriously delayed by the loss of all field records in a disastrous fire at offices in Canberra in 1953, embodies the results of a comprehensive study of the area—part of the Canning Basin in the north-east corner of the State. The survey covered nearly 40,000 square miles of remote territory, which includes the West Kimberley pastoral district, the surface geological work being supplemented by geophysical surveys. Thicknesses of 20,000 ft. of sedimentary rocks have been proved in several places, among them several sequences of the petroleum source-bed type, and structures favourable for the accumulation of oil have been delineated. Only a few bores have so far been drilled in the Basin, but several small shows of gas and oil have been obtained. The latest bore to be drilled, Wapet's Meda No. 1, which is still in progress, has yielded shows of gas and traces of oil.

IMPERIAL College Commemoration Day was celebrated as usual on October 23, the principal event being the presentation of the diplomates of the three colleges and the awards of Fellowships and honorary associateships in the Royal Albert Hall. This year the Special Visitor was Lord Bridges, formerly Secretary to the Cabinet and later Permanent Secretary, H.M. Treasury. In the course of his speech the Rector, Dr. R. P. Linstead, had something to say about the expansion progress of the College, at which there are 2,580 students this session, of whom 1,650 are undergraduates and 930 post-graduates. The College plan for expansion, made some years ago, set a total of 2,550 students as the target for 1959–60, so that it is one year ahead of its plan in so far as numbers are concerned. Six new professors and twelve new readers have been appointed during the year, eight of these being new posts established by the University of London and representing new academic developments in a number of fields including applied electron physics, heat transfer, nuclear technology, and physical oceanography. The first stage of the very large new Engineering block is going forward and the new Physics building in Prince Consort Road is also in course of construction. Both should be completed by the end of 1959. Weeks Hall, the first new hall of residence, made possible by the generosity of Vickers, Limited, is well advanced in Prince's Gardens and expected to be ready for occupation next session, while site clearance on the south and east sides of Prince's Gardens is under way and approval has been given to build on the south side four halls of residence and new refectories. Work here is expected to start next summer.

Royal School of Mines Dinner

The 74th annual dinner of the Royal School of Mines Association, held once again in the Apothecaries' Hall, took place on November 4 and proved as usual to be a pleasantly successful function. Mr. A. F. Radcliffe, this year's president of the Association, took the chair, his principal guests being Mr. A. Chester Beatty, the chairman of Selection Trust, Ltd., and Sir Harold Bishop, president of the Old Centralians and Chief Engineer to the B.B.C. The attendance of old Associates was good, the occasion becoming the usual get-together of old friends and their guests.

Proposing the toast of the Association Mr. Chester Beatty struck a serious note, referring as so often is the custom these days, to present-day trends in technological training. He suggested that the current recession in business was unlikely long to interfere with the world's incessant demands for metals. An industry so soundly based as mining had, therefore, a constant need for good men technically trained. The question of good technical training, said Mr. Beatty, became each day of greater importance, particularly as it no longer paid a mining finance house to plan its programmes

of expansion on outcrops alone! The president, in reply, was able at once to give some sort of re-assurance as to the future numbers of mining aspirants, pointing out that this year's intake into the Royal School of Mines was at a rate about equal to the School's entire strength in the period between the two wars. However, the president was nevertheless concerned at the type of education forced on the young engineers of to-day, since they have now to make such progress in their secondary schools as will enable them to enter straight into the college second year. That meant, said Mr. Radcliffe, that the final two school years, now devoted to specialist scientific subjects, could only be weathered by a sacrifice of matters of wider interest and too early a neglect of the humanities. Education proper, he suggested, now seems to have to stop at the age of 15, which was a serious business.

This matter cropped up again when Sir Harold Bishop, responding to the toast of the guests, described this question of over-specialization as something the Imperial College and, indeed, other institutions like it had seriously to bear in mind. They had, he said, to accept the situation as a challenge. If they were to be forever asked to accept College entrants "under educated" in the wider sense then they must find the means of encouraging self help and realization in the student himself. Much talent was going into the Imperial College and it was up to that College to see their students well trained to make the best use of it.

Minerals in the Solomons

It was in 1956 that a note on gold discoveries in the Solomon Islands [1] appeared in the MAGAZINE. At that time several gold-bearing bodies had been discovered by the Government Geological Survey on Gold Ridge, apparently the long-sought source of the gold that had been known to occur on the northern slopes of Guadalcanal. This, considered by Mr. J. C. Grover, the Senior Geologist of the Survey, to be "one of the more important developments in the years 1953–1956," has now been covered in much greater detail in a new memoir [2] dealing with those years which has recently been published. From the date of the discoveries on Gold Ridge in 1955 prospecting activities in the Islands increased considerably. A pyrite deposit was discovered at the head of the Tina River and a phosphate deposit of some importance was opened on Bellona Island.[1] Since then heavy-mineral-bearing beach sands have been discovered on various islands. According to the memoir referred to some of these are still the subject of study, although in the period reviewed fundamental mapping remained the Survey's principal aim.

The memoir comprises three parts, the first giving "General Information," the second discussing the "Structure of the Region," and Part 3 describing the "Geology of Individual Islands, Mineral Deposits, etc." At present the Solomon Islands Protectorate is almost entirely dependent on copra production, "a commodity whose world price is falling." In this light it can be noted that the authorities are fully appreciative of the importance of mineral developments and they have set out to encourage bona fide prospectors and mine operators. In 1952 the Mining Regulations were amended and brought up to date, the new ones being drawn up in line with the principles that prospectors and operators had the right to secure title provided statutory conditions were observed and that Government had the right to certain rents, royalties, and taxes. Now prospectors' rights and licences are readily available, while a Mining Lease for a term up to 21 years is calculated to give security of tenure and a clear right to mine.

The work done to date has indicated mineral possibilities that seem well worth further investigation. Enough is known now to give "a picture of the history and structure of portions of the region and to raise hopes of economic potential," although it is realized that "there are still gaps to be filled in critical areas." Now, it is thought, much good would eventuate out of serious oceanographic and geophysical studies. For example, submarine gravity surveys in conjunction with work ashore would help to elucidate structures, while the disasters that occur in these waters from time to time indicate the need of a sound meteorological service. In addition, coast surveys and seismic research could all help to give clear understanding of the economic geology of

[1] July issue.

[2] "The Solomon Islands—Geological Exploration and Research, 1953–1956." London: Crown Agents for Overseas Governments and Administrations. Price 40s.

[1] THE MINING MAGAZINE, Jan., June, 1957.

a part of our Commonwealth it is surely our clear duty to encourage as well as simply to " protect."

Transvaal and O.F.S. Chamber of Mines

Attention was called to the address of Mr. H. C. Koch at the annual meeting last June of the Transvaal and Orange Free State Chamber of Mines in the July issue, but in the light of a recent report of the Chamber it is worth recalling his views on the need for mine trainees which were expressed at the time. The South African gold-mining industry, Mr. Koch then said, required every year an intake of 1,000 new men of the right calibre, while at present only some 600 or so are completing training. In the event the continuation of recruitment in Europe is needed, particularly, as he said, since in South Africa sufficiently effective action to train more engineers and scientists had not yet been taken. During the last ten years the number coming from the universities had remained more or less unchanged. As an industry they continued to give encouragement to the training of engineers and scientists, but the problem was one of such complexity that no appreciable progress could be hoped for until it was tackled by the Union Government on a broad and national basis.

In the report already referred to it is pointed out that the accident rate in respect of the total gold-mining complement of members was 1·5 per 1,000 in 1957, against 1·65 and 1·49 in the two previous years. It remained the policy of the Chamber that the Rand mines should use their own labour wherever possible. Maintenance work necessary after the installation of any plant by outside contractors should continue to be carried out by contractors, at the discretion of any mine manager concerned, until such time as the plant was running satisfactorily and until sufficient mechanics/artisans were available on the mine to carry out the maintenance work. In contracts with outside firms the Chamber was not prepared to recommend limitation of employment of artisans to members of trade unions. The improved rail transport position has made it possible for all the coal requirements of gold mines to be covered by railed supplies instead of as previously by road transport supplies.

Programmes of research were continued by the Chamber's laboratories. Work on the physiological assessment of work capacity, including initial studies in the climatic chamber, is in progress, the latter being essential preliminaries to an accelerated programme on the effects of heat on work capacity and work performances of mine labour. Studies *in situ* in mines are projected and, as a preliminary, operational scientific study has been in progress for some time at what is believed to be E.R.P.M. The programme of acclimatization to underground conditions is still being extended, with the Chamber continuing to give a vigorous lead in this, especially in the Free State field. Tests on underground electrostatic filter units have been concluded and recommendations for improving their performances made. Tests of new types of air filters were effected. Dust conditions at certain mine surface plants were specially investigated. A comprehensive sampling survey of airborne dust in collieries has been completed, involving the taking of about 4,000 samples by the modified thermal precipitator. In addition, ventilation conditions were measured in about 300 underground working sections of collieries. Electron microscope studies of dusts were continued. Investigation of the assessment of the accuracy of light microscope particle sizing by means of the electron microscope was concluded.

Timber research embraces the relation between underground conditions and the necessity for preservative treatment of timber; the effect of temperature and humidity on the rate of decay of timber by mine fungi which involved the development of a new method for assessing that rate by measurements of changes in the natural resonant frequency; non-pressure methods of impregnation; the behaviour of timbers in contact with sulphuric acid and underground service tests of timber preservatives; determination when infection of imported pitch-pine by fungi occurs. Service tests with rot-proofed fabrics and ropes and testing of new rot-proofing treatments for fabrics and examination of new types of fabrics for rot- and fire-proof qualities were effected. Experiments were conducted to determine the relation between temperature and the rate of growth of fungi occurring in various recovery processes.

Finally, note can be taken of the fact that, according to Chamber, in the 18 months to the end of 1957 Calcined Products (Pty.), Ltd., processed 7,991 tons of U_3O_8, including 2,983 tons in the last six months.

MONTHLY REVIEW

Introduction.—The increasing firmness of metal prices over the first part of the current month may indicate that consumers, for some time evidently living on stocks, have again entered the markets. The recovery in wolfram prices has been particularly noticeable, while the end of the strike in Northern Rhodesia, the effects of which are dealt with elsewhere by our Metal Markets correspondent, has not deterred purchasers of spot copper.

Transvaal.—The output of the Rand mines for September amounted to 1,465,697 oz., making with 36,799 oz. from outside producers, a total of 1,502,496 oz. for the month. The number of natives employed in the gold mines at the end of September was 333,380, as compared with 334,815 at August 31 last.

WEST DRIEFONTEIN GOLD MINING reports a profit of £7,785,744 for the year to June 30 last, dividends totalling 7s. 3d. a share requiring £2,552,392 of this amount. In the year the 910,000 tons of ore milled yielded 873,140 oz. of gold and 159,543 lb. of uranium oxide. Ore reserves at June 30 are given as 2,546,000 tons averaging 16·8 dwt. in gold and 0·23 lb. of uranium oxide per ton.

In the year to June 30 last DOORNFONTEIN GOLD MINING treated 1,030,000 tons of ore and recovered 427,361 oz. of gold and 114,845 lb. of uranium oxide, operations resulting in a profit of £2,423,725. Dividends equal to 2s. a share required £982,000. The ore reserve fully developed at June 30, 1958, was estimated to be 2,507,000 tons averaging 7·4 dwt. per ton over an estimated stoping width of 41·3 in. The uranium oxide content of the ore reserve was estimated to be 0·19 lb. per ton.

The accounts of SUB NIGEL for the year ended June 30 last show a profit of £393,352 and £265,781 taken for dividends equal to 3s. a share. The 795,500 tons of ore crushed in the year yielded 197,915 oz. of gold, the reserves at June 30 being estimated as 717,000 tons averaging 7·9 dwt. In his statement to members the chairman said that it was considered that the time has arrived when the amounts realized from future working profits, as well as any amounts arising from time to time from the disposal of assets, should be distributed as capital repayments and, with the approval of members, it is the intention to adopt this policy.

The report of VENTERSPOST GOLD MINING for the year to June 30 last shows a profit of £709,435; of the £787,676 shown available, dividends equal to 1s. 9d. a share require £428,750. In the year 343,028 oz. of gold were recovered from 1,426,000 tons of ore milled. Ore reserves are given as 2,157,000 tons averaging 5·6 dwt. a ton in value.

Dividends equal to 7d. a share require £231,504 of the £678,375 profit earned by LIBANON GOLD MINING in the year to June 30 last. In the year 1,216,000 tons of ore milled yielded 275,280 oz. of gold. At the year end the ore reserves were estimated to be 2,450,000 tons averaging 4·8 dwt. per ton.

The operations of LUIPAARDS VLEI in the year ended June 30 last resulted in a profit of £1,062,403, the accounts showing £1,272,021 available, of which dividends equal to 2s. 2d. a share required £538,320. In the year the Main Reef Section recovered 152,539 oz. of gold from 853,000 tons of ore milled, while the Bird Reef yielded 18,811 oz. of gold and 740,544 lb. of uranium oxide from 597,000 tons. Reserves on Main Reef are given as 1,424,000 tons averaging 4·5 dwt. and on Bird Reef as 849,000 tons averaging 1·3 dwt. in gold and 1·9 lb. per ton in uranium oxide.

In the year to June 30 last BLYVOORUITZICHT GOLD MINING recovered 734,191 oz. of gold and 639,266 lb. of uranium oxide from 1,244,000 tons of ore treated, operations resulting in a profit of £3,310,610. Dividends equal to 2s. a share require £2,400,000 of this amount. Available reserves at June 30 last are given as 4,660,000 tons averaging 14·3 dwt. in gold and 0·516 lb. in uranium oxide per ton.

The accounts of CONSOLIDATED MAIN REEF MINES for the year ended June 30 last show a profit of £173,050 and £577,071 available, of which dividends equal to 2s. 6d. a share require £155,950. In the year the company treated 1,740,000 tons of ore and recovered 265,432 oz. of gold. The ore reserves available at the end of the year are estimated as 568,000 tons averaging 4·3 dwt. in value.

The 1,643,000 tons of ore treated by MODDERFONTEIN EAST in the year to June 30 last yielded 162,744 oz. of gold, operations resulting in a profit of £45,210. Of the £291,935 shown available in the accounts £69,810 is required for dividends equal to

1s. 6d. a share. At the end of the year under review the ore reserves available were estimated as 767,000 tons averaging 3·6 dwt. in value.

In recent circulars shareholders of WESTERN REEFS EXPLORATION AND DEVELOPMENT and of VAAL REEFS EXPLORATION AND MINING were informed that now that ZANDPAN GOLD MINING has been granted a Mining Lease they will be entitled to a share in the 5,200,000 shares of 10s. each to be offered at par by the Zandpan company.

The TRANSVAAL ORE COMPANY recently stated that the vermiculite ore reserves at present being worked at Palabora now exceed 100,000,000 tons ; the length and the width of the working is slightly larger than 1,000 ft., with a maximum depth of 85 ft. The concession rights for the crude vermiculite are held by MANDOVAL, LTD., of London, who import to Europe and the U.K., as well as countries all over the world.

In the three months to September 30 last the MESSINA (TRANSVAAL) DEVELOPMENT COMPANY mined 246,236 tons of ore containing 3,767 tons of recoverable copper.

The accounts of ROOIBERG MINERALS DEVELOPMENT for the year ended June 30 last show a profit of £72,892 and £136,872 available, of which a dividend of 7½% requires £15,000. The company's output of concentrates for the year is given as 1,081 tons.

In a preliminary announcement last month shareholders of APEX MINES are informed that the directors have decided that in order to help to counteract fluctuating supplies of native labour No. 4 seam at Greenside colliery should be opened up and equipped to produce an output of 30,000 tons to 35,000 tons of coal per month by employing mechanized methods wherever possible. In order to raise the capital required to finance the scheme it is proposed that an issue of 300,000 ordinary shares of 10s. each be made.

Orange Free State.—HARMONY GOLD MINING reports a profit of £3,011,466 for the year to June 30 last, the accounts showing £4,274,773 available, of which dividends equal to 1s. 9d. a share require £1,575,000. In the year 952,000 tons of ore milled yielded 381,877 oz. of gold and 477,673 lb. of uranium oxide. The available ore reserves at the year end are given as 2,841,000 tons averaging 9·2 dwt. in gold and 0·657 lb. in uranium oxide per ton.

Last month the directors of PRESIDENT BRAND GOLD MINING announced that borehole SP6, drilled at a point 2,650 ft. to the east of No. 2 shaft for geological information, intersected the reef at 7,242 ft. from the surface. An incomplete exposure was obtained with values averaging 29·94 dwt. over a width of 36 in., uranium values being 0·407 lb. over a similar width. A deflection was made and a complete exposure obtained at 7,240 ft., with the following values—173·15 dwt. in gold, and 2·074 lb. of uranium oxide over 19·5 in.

Earlier this month shareholders of FREE STATE SAAIPLAAS GOLD MINING were informed that on November 2 last the Leader Reef was intersected in No. 2 shaft at a depth of 5,939 ft. below collar. The exposure was complete and sampling around the periphery of the shaft showed negligible values. On November 4 the Basal Reef was intersected at 5,960 ft., the exposure being complete. Sampling around the periphery of the shaft averaged 16·7 dwt. per ton over a reef channel width of 15·4 in.

Southern Rhodesia.—The accounts of CAM AND MOTOR GOLD MINING for the year to June 30 last show a profit of £382,054 and £449,208 available, of which dividends equal to 40% require £225,000. In the year 371,998 tons of ore was milled and 115,995 oz. of gold recovered. Ore reserves in the Cam and Motor mine at June 30 are given as 1,231,800 tons averaging 7·2 dwt. in value, in addition to 297,500 tons averaging 5·2 dwt. in the Pickstone mine.

LONDON AND RHODESIAN MINING AND LAND reports a profit of £41,532 for the year ended June 30 last, the accounts showing £98,982 available, of which £28,750 is required for a dividend equal to 5%.

Northern Rhodesia.—Preliminary figures issued by MUFULIRA COPPER MINES for the year ended June 30 show a total of 92,904 long tons of new copper produced. Operations resulted in a profit of £2,720,033, of which dividends totalling 3s. 3d. a share require £1,611,454. In the same year CHIBULUMA MINES produced 27,177 long tons of new copper and made a profit of £1,151,473.

Ghana.—In the three months to September 30 last BREMANG GOLD DREDGING treated 2,489,500 cu. yd. of ground and recovered 14,549 oz. of gold. The report for the quarter states that No. 1 dredge was shut down for 151 hours in July ; in spite of this, and an " unprecedented " drought during the quarter, the overall profit for the period constitutes a record. It is anticipated that No. 3 dredge will have completed operations

on the Ankobra River during the next quarter and preparatory work for its removal to the Offin River is making good progress.

Nigeria.—The report of the AMALGAMATED TIN MINES OF NIGERIA for the year ended March 31 last shows a production of 4,083 tons of cassiterite and 505 tons of columbite. Operations resulted in a profit of £464,006, of which dividends equal to 14% require £156,975. Cassiterite reserves at the year end are given as 42,037 tons, of which 1,888 tons are transferred from KEFFI TIN and LONDON NIGERIAN MINES.

Sierra Leone.—It has been announced recently that the HANNA COAL AND ORE CORPORATION, which earlier this year carried out a preliminary survey of iron-ore deposits in the South Eastern Province of Sierra Leone, does not intend to continue the exploration programme at present. The Corporation came to this decision because of the present economic situation of Sierra Leone and an apparent lack of quality and quantity in the deposits believed to exist. It is possible that the Corporation may seek to continue the operations in Sierra Leone at a future date, it is stated.

Tanganyika.—At the end of October it was announced that the consent of the Capital Issues Committee of H.M. Treasury had been received to the issue of 1,000,000 shares of £1 each in KENTAN GOLD AREAS, which it is proposed to offer to all the stockholders of the ZAMBESIA EXPLORING COMPANY by way of a £ for £ exchange. Proposals providing for the re-organization of the company's share capital were approved at the extraordinary meeting held on November 10. In the September quarter GEITA GOLD MINING milled 54,050 tons of ore and recovered 10,200 oz. of gold. The working loss for the period is given as £10,127.

Australia.—On October 27 Mr. Menzies, Prime Minister of Australia, flew from Canberra to Queensland officially to open the Mary Kathleen uranium mine. In fact the first uranium oxide had been produced there about four months ago, but the Prime Minister said that at the date of the opening the first consignment of 100 tons was being loaded for shipment to England. The Mary Kathleen discovery, made in 1954, has thus been brought into production in record time. In fact, once construction got under way, it was completed in less than 2½ years. Under the guidance of the RIO TINTO MINING CO. OF AUSTRALIA a new and active community has thus been set up in an area at one time thought almost barren.

With the recent dividend notice shareholders of MOUNT ISA MINES have been informed that in addition to the final dividend the directors also recommend a distribution of 7½d. (Australian) per stock unit to be declared out of income, exempt from income tax and to be satisfied not by cash but by an issue of fully-paid shares of 5s. (Australian) each at par, being one fully-paid share for every eight stock units held. The new shares are to be converted into stock units of 5s. (Australian) each by resolution at the annual general meeting. The profit for the year ended June 30, 1958, is £A1,424,129, after providing £A250,000 for income tax, £A350,000 for provision for tax equalization, and £A1,001,111 for depreciation. The directors have appropriated £A400,000 for capital expenditure and development.

New Guinea.—In the three months to August 31 last BULOLO GOLD DREDGING treated 1,169,800 cu. yd. of ground and recovered 5,452 oz. of gold. The net profit from the dredge and sluicing operation for the quarter is estimated at $61,000, as compared with $139,700 for the same period of the previous year.

British Guiana.—Early this month the directors of BRITISH GUIANA CONSOLIDATED GOLDFIELDS announced that " in the face of a fixed price for gold, steadily rising costs of labour and materials, combined with technical difficulties and labour troubles, dredging operations on the Konawaruk River are uneconomic." The board has decided to cease operating in that area and placed the dredge on a care and maintenance basis. It is stated that the cost of dredging in British Guiana has greatly increased over the past seven years and the board is actively engaged in re-appraising the company's future.

Canada.—Figures released on November 7 by the RIO TINTO MINING CO. OF CANADA show that in the nine months to September 30 last PRONTO URANIUM MINES milled 408,251 tons of ore and made a profit of $2,113,000, while ALGOM URANIUM MINES treated 1,561,000 tons for a profit of $7,347,000. In the same period RIX ATHABASCA URANIUM milled 54,075 tons for a profit of $382,000.

The interim report of the INTERNATIONAL NICKEL CO. OF CANADA and subsidiaries for the nine months ended September 30, 1958, shows net earnings in terms of United States currency of $30,321,000 after all charges,

depreciation, depletion, taxes, etc. For the corresponding first nine months of 1957 the income was $66,017,000. Revenue of $8,920,000 in the three months ended September 30, 1958, compares with $9,188,000 in the second quarter. In the three months ended September 30, 1957, net earnings were $20,416,000. Nickel deliveries during the first nine months of the current year are down 33% from the same period in 1957. Copper prices and platinum metals deliveries and prices were also much less.

ALUMINIUM, LTD., announced recently a consolidated net income of $17,988,000 for the nine months ended September 30, as compared with $30,926,000 in the corresponding period of last year. Consolidated sales were $270,034,000 in the period, against $286,875,000 last year, while the cost of sales was $161,677,000 against $172,892,000. The ALUMINUM CO. OF CANADA, whose accounts are consolidated, reported a net income of $17,879,321 for the nine months.

Portugal.—In his speech to shareholders of BERALT TIN AND WOLFRAM at the recent annual meeting the chairman, Mr. F. Gates, referred to Argimela, the tin-bearing property some 27 miles distant by road from Panasqueira, owned through a wholly-owned Portuguese subsidiary company known as E.M.A.L. Following an extensive sampling programme the evidence suggests that it contains a large tonnage of tin ore, the average grade of which, however, seems barely sufficient to justify a large-scale bulk operation, although there are smaller blocks of higher grade which it may be possible to work profitably by other mining methods. Mining on one or two selected veins has so far indicated an average grade of the same order as at Vale da Ermida.

United Kingdom.—The ore mining branch of the UNITED STEEL COMPANIES, LTD., are developing a new underground ironstone mine in the parish of Easton, near Grantham, to be known as Easton mine. Site preparation has already begun on the new mine, it is stated, which will be the first to be developed by United Steel on the Northamptonshire sands ironstone bed.

Cementation Company.—The consolidated accounts of the Cementation Co., Ltd., for the year to March 31 last show a profit of £471,884 and £854,506 available. Dividends equal to 12½% on the ordinary shares require £258,462, leaving £596,044 to be carried forward.

DIVIDENDS DECLARED

* Interim † Final

(Less Tax unless otherwise stated.)

Aluminium, Ltd.—Quarterly 17½ cents, payable Dec. 5.

***Ayer Hitam Tin Dredging.**—3d., payable Nov. 14.

†**Cementation Co.**—12½%.

†**Consolidated Gold Fields of South Africa.**—3s. 6d.

†**Coronation Syndicate.**—4d., payable Feb. 5.

†**Ipoh Tin Dredging.**—2s., payable Dec. 9.

†**Kamunting Tin Dredging.**—1s., payable Nov. 28.

***Kinta Tin Mines.**—3d., payable Oct. 31.

†**Lake View and Star.**—1s. 6d., payable Dec. 19.

***Loloma (Fiji) Gold Mines.**—1s. (Aust.), payable Dec. 19.

†**London and African Mining Trust.**—2·4d., payable Nov. 18.

***McIntyre Porcupine Mines.**—50 cents, payable Dec. 1 ; $1·00, payable Jan. 2.

†**Messina (Transvaal) Development Co.**—4s., payable Dec. 19.

†**Mount Isa Mines.**—3d. (Aust.), payable Jan. 1.

Mount Morgan.—Pref. half-yearly, 3½%, payable Dec. 31.

†**Mufulira Copper Mines.**—2s. 7d., payable Dec. 15.

†**New Guinea Goldfields.**—3d. (Aust.), payable Dec. 15.

†**Pahang Consolidated Co.**—2½%, payable Dec. 13.

***Premier (Transvaal) Diamond Mining Co.**—Pref. 12s. 6d., payable Nov. 28.

†**Renong Tin Dredging.**—6d., free of tax, payable Dec. 11.

†**Rhodesian Anglo American.**—4s. 9·6d., payable Dec. 11.

†**Rhodesian Selection Trust.**—6d., payable Dec. 15.

†**Rhokana Corporation.**—32s., payable Dec. 11.

***Sungei Besi Mines.**—4·8d., payable Nov. 12.

***Tanjong Tin Dredging.**—6d., payable Oct. 31.

†**Temoh Tin Dredging.**—6d., payable Dec. 9.

***Union Corporation.**—1s.

***Union Minière du Haut-Katanga.**—Fr. 600.

†**Wankie Colliery Co.**—9d., payable Dec. 5.

METAL PRICES

Nov. 10.

Aluminium, Antimony, and Nickel per long ton ; Chromium per lb. ; Platinum per standard oz. ; Gold and Silver per fine oz. ; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	180	0	0
Antimony (Eng. 99%)	190	0	0
Chromium (98%–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	21	5	0
Silver		6	5¾
Gold	12	10	1½
Wolfram (U.K.)		—	
(World)		4 2	6

Tin, Copper, Lead, Zinc — See Table, p. 304.

A System of Ore Mineral Identification

S. H. U. Bowie [1] and K. Taylor [1]

Reflectivity and micro-indentation hardness used as accurate measurements

Introduction

Just over 50 years ago Campbell (1) [2] made the first important contribution to the systematic determination of ore minerals by suggesting the possibility of identifying opaque minerals using a reflecting microscope and observing such properties as colour and etch reactions. The importance of this technique was quickly realized and by 1916 Murdoch (2) had published his well-known system of opaque mineral identification based primarily on colour and scratch hardness. Further contributions to the determination of minerals were later made by Davy and Farnham (3), Schneiderhöhn (4), Van der Veen (5), Schneiderhöhn and Ramdohr (6), and by Short (7). Short's system has been widely adopted, but the fact that the ore microscope has not yet been utilized to anything like the same extent as the petrological microscope is testimony mainly to the difficulties and ambiguities associated with any scheme of ore mineral identification relying on scratch hardness, etch reactions, or microchemical tests. Recently Uytenbogaardt (8) has prepared a comprehensive set of tables for the identification of ore minerals but these have two serious drawbacks. First, they depend on the commonly unobservable property of " resistance to polish " ; secondly they rely on etch tests, which are time consuming and unreliable, particularly in the examination of fine-grained intergrowths or aggregates. No criteria have been suggested to make the system more reliable than its predecessors.

Researches carried out by the senior author (9) (10) indicated that a system based primarily on the accurate measurement of reflectivity and micro-indentation hardness might make the determination of opaque minerals not only more precise but quicker than had been previously possible. This expectation has been amply borne out by subsequent work and from the preliminary data presented here it is clear that most of the common ore minerals can be identified by accurate measurements of hardness and reflectivity, taken together with other readily observable properties such as colour, anisotropism, polarization colours, and bireflection.

Measurement of Reflectivity

The accurate determination of the reflectivity [1] of minerals in polished section has been regarded for many years as a valuable aid to their identification. Reflectivity can be measured visually or photoelectrically, but it is generally agreed that the photoelectric method is capable of greater accuracy provided the mineral grains are not unduly small. Hitherto, however, no simple, inexpensive, and yet reliable apparatus has been described to exploit this potential accuracy fully. The photoelectric method was first employed by Orcel (11), (12), (13) in France, using an alkali-metal cell. A few years later Ehrenberg and Ramdohr (14) in Germany and Moses (15) in the United States of America independently conducted detailed investigations on the reflecting power of minerals using rectifying cells. More recently Folinsbee (16) has made a contribution to the simplification of reflectivity measurements by employing a standard photographic exposure meter coupled directly to an ore microscope; but the accuracy sacrificed by the employment of this technique more than outweighs its advantages. A further drawback of Folinsbee's method from the point of view of practical mineragraphy is that measurements cannot be made on grains less than 1 mm. across.

The apparatus described in this paper has been used for six years and during this time has proved to be not only robust and reliable but capable of measuring the relative reflectivity of ore minerals within the desired precision of *plus* or *minus* 1% of the measured value. The photoelectric-cell characteristics have been tested periodically throughout

[1] Atomic Energy Division, Geological Survey of Great Britain.

[2] Figures in parentheses refer to the list of references given at the end of this article.

[1] Defined as the percentage of normally incident light reflected from the surface.

the trial interval and as they have not changed appreciably the apparatus seems to be highly satisfactory in every way.

Measurements can be made on grains down to about 0·06 mm. in diameter, using the unamplified output of the selenium cell. With more elaborate apparatus involving the use of an amplifier or photomultiplier tube it is possible to obtain measurements on grains of even smaller size and experimental work is in progress to establish which technique is most convenient to use in the determination of very small grains.

Description of the Apparatus

The essential components of the apparatus are an ore microscope with a tube iris diaphragm, a selenium barrier-layer cell in a suitable holder, and a sensitive galvanometer with a relatively low internal resistance. In localities where there are large fluctuations in both mains voltage and frequency the light source must be stabilized, but elsewhere this refinement is not essential for diagnostic purposes.

Microscope.—A microscope with a cover-glass reflector unit, bloomed objectives, and external illumination is necessary for good results. That used by the writer is a standard Cooke, Troughton, and Simms ore microscope to which an additional iris has been fitted in the tube just below the base of the ocular. The purpose of this iris is to cut out stray light reflected from minerals outside the field being examined. Use could be made of the iris diaphragm normally available on microscopes fitted with a Wright slotted ocular and the cell could be mounted in the accessories carrier. Whatever type of housing is used for the cell it is essential for accurate work that an iris be provided as near as possible to the sensitive surface of the cell.

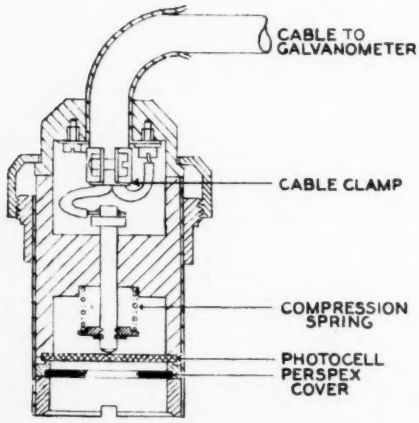


Fig. 1.—Section Showing Construction of Cell Mount.

Cell Holder.—The cell holder was designed so that it could replace the ocular easily and in such a way that the sensitive surface of the cell would always take up a position in the plane of the primary image of the mineral under examination.

The construction of the cell mount shown in Fig. 1 is probably more elaborate than necessary, but as this is essentially an experimental model it was necessary to make it so that the cell could be replaced easily and filters introduced below the sensitive surface.

Galvanometer.—A spot galvanometer is employed with an internal resistance of 450 ohms and with a linear scale graduated from 0 to 100. The instrument used is manufactured by the Cambridge Instrument Co., Ltd., but other suitable galvanometers are available.

Photoelectric Cell.—Photoelectric cells of barrier-layer type offer several advantages over gas-filled or vacuum cells for measurements of the type described here. The most important of these are long life, robustness, compactness, and the ability to deliver an electric current without the necessity of applying an external potential. The current generated when the sensitive surface of the cell is illuminated is directly proportional to the illumination when, as in this case, the internal resistance of the cell is high and the external load resistance is comparatively low.

Of the cells tested, the selenium barrier-layer type manufactured by Evans Electroselenium, Ltd., delivered the greatest current for a given intensity of illumination, gave near linear response over the range of illumination used, and showed no signs of fatigue.

Stabilization of the Light Source

One of the major problems in the use of photoelectric techniques for measuring reflectivity under an ore microscope is the stabilization of the light source. A number of methods have been tested, including the use of a constant-voltage transformer and the use of high-capacity accumulators alone, but only

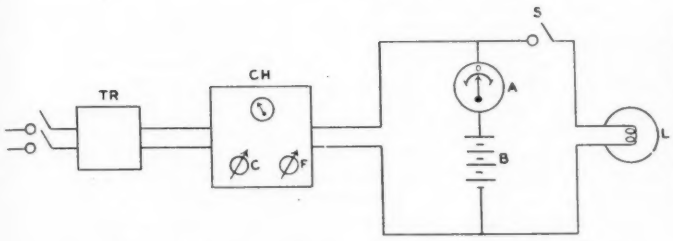


Fig. 2.—Layout of the Stabilization Circuit :

TR, transformer ; CH, charger ; C, coarse adjustment ; F, fine adjustment ; A, ammeter ; B, battery ; S, switch ; L, lamp.

one of the methods tried has produced satisfactory results. Typical readings taken at the same time of day in each case are given in Table 1 to show the effect of using unstabilized light, light stabilized by a constant-voltage transformer, and light stabilized by the method finally adopted.

Table 1

The Effect of Various Lighting Circuits on the Observed Reflectivity

A pyrite standard was used and the irises adjusted to give an initial reading of 54·5 in each case.

Time	*Unstabilized illumination*	*With constant-voltage transformer*	*Stabilized illumination*
1500 hours	54·5	54·5	54·5
1505 ,,	53·5	54·0	54·5
1510 ,,	54·0	54·6	54·5
1515 ,,	54·6	54·0	54·4
1520 ,,	54·2	53·9	54·5
1525 ,,	53·9	53·9	54·5
1530 ,,	54·0	54·0	54·5

The arrangement employed is shown diagrammatically in Fig. 2. A constant-voltage transformer (TR), which has coarse (C) and fine (F) adjustment controls on the output current, is used to supply a partially stabilized current to a heavy-duty accumulator charger (CH). The battery (B), which is kept charged, has the requisite number of heavy-duty car-starter cells and is connected in series with a -10, 0, $+10$ ammeter (A) across the charger. The lamp (L) used by the writers is a compact tungsten-filament type that consumes 48 watts at 8 volts and hence requires a current of 6 amps. This is supplied by the charger, which is normally adjusted by the fine control to give an ammeter reading of zero.

The stabilizing effect of the heavy-duty battery in this circuit results from its very low internal resistance. Any fall in the current supplied through the charger would be compensated for by current taken from the battery and any excess current from the charger would be diverted through the battery.

It is necessary to give the battery a charge periodically. This can be achieved simply by opening the lamp switch (S) while the charger is still operating. After charging the battery voltage should be allowed to settle for an hour or so before it is used again for making accurate measurements. During normal use the battery and light are switched off simultaneously.

Calibration

One of the main disadvantages of the early barrier-layer cells was the variability in sensitivity over their surface. Obviously this would have been a serious drawback to accurate measurements and one of the first tasks of calibration was to test the response

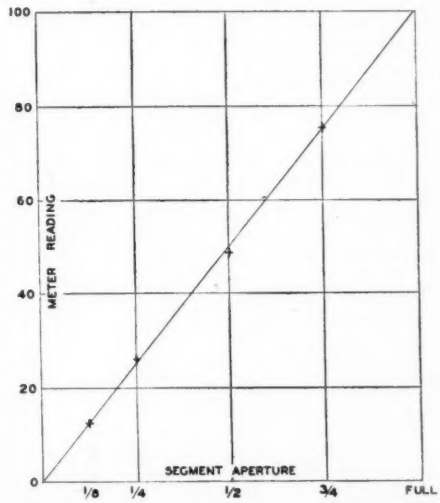


Fig. 3.—Linear Response of Cell and Galvanometer.

of the cell over its entire surface. To do this a disc from which a one-eighth sector had been machined out was placed beneath the cell in the holder and rotated through a complete circle ; at the same time the light falling on the cell was kept constant. No variation in galvanometer reading was observed during the rotation of the disc through 360°.

The next step in the calibration of the instrument was to determine whether the response of the combined cell and galvanometer was linear. This was done in two ways. First, a highly reflecting mineral was placed on the microscope stage and the field iris opened until the reading on the galvanometer was 100. Discs from which $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, and $\frac{3}{4}$ sectors had been cut were then inserted in turn in the cell holder and the readings noted. The results shown in Fig. 3 demonstrate that the response is linear. A second test, which checked not only the linearity of the response but also its reproducibility, was made by inserting accurately calibrated neutral density filters in front of the light source. The results of this experiment are shown in Table 2. The filters were calibrated by the National Physical Laboratory using a tungsten-filament lamp operating at a colour temperature of 3,050° K., which is the same as that of the microscope lamp employed. The percentage transmission values measured photoelectrically agree closely with those determined by the National Physical Laboratory. However, as there is some variation from cell to cell, new cells should always be tested for linearity before use.

Table 2

Calibration Data on Three EEL Cells

*Density**	*Percentage transmission*	*EEL cell No. 551*	*EEL cell No. 1054(a)*	*EEL cell No. 1054(b)*
0·114	76·9	77·0	77·0	77·5
0·310	49·0	49·0	49·0	49·1
0·542	28·7	28·7	28·5	28·2
1·046	9·0	9·0	9·0	8·9
2·159	0·7	0·7	0·7	0·7

* Defined as the logarithm of the reciprocal of the transmission of the neutral filter used.

Choice of Reflectivity Standard

The choice of a reflectivity standard has been the subject of discussion for many years, but none has yet been universally accepted. This is partly owing to the difficulty of making absolute reflectivity measurements at normal incidence and partly to the lack of an ideal substance. A good standard should have a high reflectivity with little dispersion and should be isotropic ; it must be free from inclusions and flaws, should polish easily without being scratched, and should have a high resistance to tarnish.

Theoretically the reflectivity (R) of a transparent isotropic medium at normal incidence in air can be calculated from the Fresnel equation—

$$R = \frac{(n-1)^2}{(n+1)^2} \times 100,$$

where n is the refractive index. A highly refracting mineral like diamond can therefore be used as a primary standard, the reflectivity being calculated for light of different wave-lengths from the corresponding refractive indices. Even diamond, however, has too low a reflectivity (17·2 in sodium light) for it to be an ideal standard and complete elimination of internal reflections is a difficult matter. As will be shown below, a carefully cut diamond may be used as a primary standard with which to establish the best reflectivity value for a secondary standard for routine use. Blende has sometimes been used as a standard but compared to diamond it has the additional disadvantage that its reflectivity depends on its iron content.

Several pure metals—namely, copper, silver, rhodium, and platinum—have been examined for use as secondary standards but none proved entirely satisfactory. A large number of mineral species have also been considered and eventually purite was chosen as the most suitable. Its surface does not tarnish readily and its reflectivity, which is remarkably constant from specimen to specimen, lies near the middle of the range found in ore minerals. A value of 54·5 has been obtained for pyrite from Rio Marina, Elba, using sodium light (or a Wratten filter 22 used in conjunction with a tungsten-filament lamp) by direct comparison with a primary standard of diamond, specially cut to eliminate internal reflections. A similar value has been proposed by Hallimond (17) using a direct method of measurement and this value can therefore be accepted with some confidence. Sections of pyrite from ten different localities have been tested for uniformity and all give values in white light within 0·1 of each other. This, of course, does not mean that all pyrite will necessarily

have the same reflectivity, but if pyrite from Rio Marina is not available it does indicate that any error introduced through not having the specified material is likely to be small.

The reflectivity of pyrite for a tungsten-filament light source operating at a colour temperature of 3,050° K. was found by comparison with diamond to be 52·8. However, as Folinsbee (16) has published values for the reflectivities of some 200 species measured relative to pyrite at 54·5, the latter value has been adopted as an interim measure until sufficient new and more accurate data are available.

Use of the Photometer

Measurement of Reflectivity.—To obtain the reflectivity of an unknown mineral the pyrite standard is first placed on the stage, brought into focus, and a scratch-free area selected. The ocular is then replaced by the cell unit and the field and tube irises adjusted till a reading 54·5 is obtained on the spot galvanometer. A box with a circular hole in the top and painted dead black inside is then placed immediately under the objective and the sub-stage raised until the bottom lens of the objective fits just inside the hole. A second reading is taken on the galvanometer and the zero-setting control adjusted until it reads zero. (This reading is necessary to compensate for stray light reflected mainly from the top surfaces of the lenses in the objective.) The standard is then replaced and the irises adjusted slightly to restore the reading of 54·5. Next, the unknown is placed on the stage, focused carefully, and a suitable area chosen as before. The new reading obtained when the cell has been put in position is then given directly on the galvanometer as percentage reflectivity. Once the microscope has been set up in this way it is not necessary to take any further measurements with the standard unless the area of field controlled by the irises is changed. If great accuracy is required readings for the standard should be obtained immediately before and after the unknown.

For best results specimens must be well polished. The criterion of a good polish is that the surface should be flat and without visible scratches at the magnification employed. The surface should be cleaned with benzene and a lens tissue before the measurement is made. (Buffing on a chamois leather pad tends to scratch soft minerals, though it is suitable for hard ones.) There is little evidence that the method of polishing has any effect on reflectivity values, but this is being investigated more fully. Tests carried out on five minerals polished with aluminium oxide and with magnesium oxide on lead laps and with aluminium oxide on a cloth lap showed no appreciable difference in reflectivity provided the specimens were equally well polished by the three methods. Results of this experiment are given in Table 3 :—

Table 3

Reflectivity Values obtained after Different Polishing Techniques

Mineral species	Al_2O_3 *Lead lap*	*MgO Lead lap*	Al_2O_3 *Cloth lap*
Pyrite	54·5	54·5	54·5
Davidite	17·2	17·2	17·2
Uraninite	16·8	16·9	16·8
Blende	17·5	—	17·4
Tetrahedrite	30·7	30·7	30·8

Bireflection.—The polished surfaces of isotropic minerals give one reflectivity value in the same way as such minerals have one refractive index in transmitted light. Similarly most sections of anisotropic minerals have two principal directions which differ in their reflecting power for rays vibrating along them. It is a simple matter to measure the maximum and minimum reflectivity in any section by rotating the stage until these values are observed. The difference between the two values gives a measure of the bireflection of the section. Any particular section may not exhibit the maximum bireflection of the mineral, just as in any thin section the maximum birefringence may not be observed; but if a number of grains of the same mineral are examined (and this can be done very quickly) the maximum and minimum values can usually be determined without much effort. Where crystallographic directions can be observed it is always useful to note the relationship between these and the principal directions. The numerical value of the bireflection is a valuable aid in mineral identification.

Dispersion.—The reflectivity of most minerals varies with the wave-length of the incident light and unless its spectral composition is defined there is little point in employing precise photometric methods for measuring the reflectivity. Unfortunately the use of a monochromator or of filters that transmit a narrow spectral band cuts down the intensity of the illumination so drastically

Table 4

Minerals Arranged in Order of Increasing Reflectivity

The values are for white plane polarized light (3,050° K.) in air relative to a pyrite standard of 54·5

Number of localities	*Mineral species*	*Mean*	*Range*	*Difference, mainly due to bireflection*
1	Coffinite	9·9	—	—
1	Scheelite	10·0	—	—
1	Zincite	11·2	—	—
2	Cassiterite	12·0	11·2–12·8	1·6
2	Chromite	12·1	—	—
2	Graphite	12·5	6·0–17·0	11·0
2	Pyrochlore	13·4	13·0–13·8	0·8
3	Covelline	14·5	7·0–22·0	15·0
3	Betafite	14·5	14·0–14·9	0·9
3	Thorianite	14·6	14·0–15·3	1·3
4	Brannerite	14·8	13·7–16·0	2·3
3	Euxenite	15·0	—	—
5	Pitchblende	16·0	—	—
1	Uraninite	16·8	—	—
2	Manganite	17·0	14·0–20·0	6·0
3	Columbite-tantalite	17·1	16·3–18·0	1·7
5	Goethite	17·3	16·1–18·5	2·4
3	Wolframite	17·3	16·2–18·5	2·3
5	Blende	17·5	—	—
1	Hausmannite	17·5	16·0–19·0	3·0
3	Davidite	17·8	—	—
1	Chalcophanite	18·1	10·2–26·0	15·8
1	Realgar	18·5	—	—
1	Jacobsite	18·5	—	—
2	Braunite	18·8	17·8–19·8	2·0
4	Ilmenite	19·4	17·8–21·1	3·3
2	Rutile	20·2	—	—
1	Lepidocrocite	20·4	15·8–25·0	9·2
4	Magnetite	21·1	—	—
4	Bornite	21·9	—	—
1	Digenite	22·0	—	—
1	Orpiment	22·6	20·3–25·0	4·7
1	Bixbyite	23·0	—	—
1	Alabandite	23·4	—	—
1	Tenorite	23·4	20·0–26·9	6·9
1	Psilomelane	23·5	23·0–24·0	1·0
1	Maghemite	25·0	—	—
3	Molybdenite	26·0	15·0–37·0	22·0
1	Proustite	26·4	25·0–27·7	2·7
3	Enargite	26·5	25·0–28·1	3·1
1	Famatinite	26·9	25·1–28·7	3·6
2	Cuprite	27·1	—	—
2	Stromeyerite	27·1	25·5–28·7	3·2
5	Hematite	27·5	25·0–30·0	5·0
2	Stannite	28·0	—	—
1	Tennantite	28·9	—	—
2	Argentite	29·0	—	—
1	Coronadite	29·0	26·0–32·0	6·0
2	Hollandite	29·2	26·0–32·5	6·5
3	Pyrargyrite	29·6	28·4–30·8	2·4
1	Freibergite	29·8	—	—
1	Pearceite	30·1	—	—
4	Tetrahedrite	30·7	—	—
4	Chalcocite	32·2	—	—
1	Zinkenite	32·3	—	—
1	Naumannite	32·6	31·0–34·2	3·2
2	Miargyrite	33·9	31·8–36·0	4·2
1	Berthierite	35·0	30·0–40·0	10·0
2	Stibnite	35·1	30·2–40·0	9·8
2	Pyrolusite	35·8	30·0–41·5	11·5
1	Bournonite	37·1	36·0–38·2	2·2
1	Jamesonite	38·0	36·0–40·0	4·0
1	Hessite	38·5	—	—
1	Emplectite	38·5	36·0–41·0	5·0

Table 4 (*contd.*)

2	Chalcostibite	40·0	37·1–43·0	5·9
2	Boulangerite	40·6	37·0–44·1	7·1
2	Cubanite	41·2	40·0–42·5	2·5
5	Pyrrhotine	41·6	38·0–45·2	7·2
1	Kobellite	42·1	40·9–43·2	2·3
4	Galena	43·2	—	—
1	Carrollite	44·0	—	—
7	Chalcopyrite	44·0	42·0–46·1	4·1
2	Bismuthinite	45·4	42·0–48·7	6·7
1	Bravoite	45·5	—	—
1	Gersdorffite	47·5	—	—
1	Ullmannite	47·5	—	—
3	Siegenite	48·6	47·3–49·8	2·5
1	Arsenic	49·5	48·0–51·0	3·0
1	Breithauptite	49·9	45·3–54·6	9·3
2	Maucherite	51·2	—	—
3	Pentlandite	52·0	—	—
4	Marcasite	52·2	48·9–55·5	6·6
1	Glaucodot	52·5	—	—
2	Cobaltite	52·7	—	—
3	Arsenopyrite	53·7	51·7–55·7	4·0
6	Löllingite	53·8	53·0–54·7	1·7
1	Sylvanite	54·0	48·0–60·0	12·0
5	Pyrite	54·5	—	—
3	Niccolite	55·1	52·0–58·3	6·3
5	Skutterudite	55·8	—	—
1	Millerite	57·0	54·0–60·0	6·0
2	Rammelsbergite	59·0	58·0–60·0	2·0
1	Pararammelsbergite	61·0	60·5–62·0	1·5
1	Tellurbismuth	61·5	60·5–62·5	2·0
1	Dyscrasite	63·2	62·0–64·5	2·5
1	Altaite	65·5	—	—
1	Bismuth	67·9	—	—
1	Platinum	70·0	—	—
2	Gold	74·0	—	—
1	Antimony	74·5	72·0–77·1	5·1
1	Copper	81·2	—	—
1	Electrum	83·0	—	—
2	Silver	95·0	—	—

that either a very powerful light source must be employed or the output from the electric cell must be amplified. The first alternative introduces stabilization difficulties, as the heavier the current required the less easy it is to obtain satisfactory stabilization of the light source. The second alternative makes the whole apparatus rather complicated for general use.

It is recommended that for normal diagnostic purposes a compact tungsten-filament lamp operating at a colour temperature of 3,050° K. be employed and that the Wratten filters be used to give a measure of dispersion of the reflectivity. It is usually sufficient to note whether the reflectivity increases or decreases with increase in the wave-length of the incident light.

Dispersion of Bireflection.—The reflectivities corresponding to the two principal directions in the surface of an anisotropic mineral often vary independently with the wave-length of the light employed. This property is termed "dispersion of the bireflection"; it can readily be measured with the apparatus described here and may in some instances be of considerable diagnostic value.

Discussion of Results

Reflectivity determinations have been made on polished sections of 103 ore minerals and the results are listed in Table 4. The ranges given for anisotropic minerals were measured on randomly orientated sections and indicate the degree of bireflection. An attempt has been made to obtain maximum and minimum values by making measurements on crystals in all possible orientations, but because of the lack of material it is unlikely that the full range will have been covered in every case. The values quoted are therefore tentative and subject to revision when more determinations have been made.

Measurement of Hardness

Scratch hardness tests have been widely used since Mohs' hardness scale was proposed in 1820, but it was not until 1925 that

Talmage (18) attempted to refine the scratch test technique by mechanical means. He obtained encouraging results though the operation of the instrument was delicate and time consuming. More recently hardness testing by micro-indentation at low loads has been used by metallurgists for investigating hardness variations over small areas of metal and this technique has been applied to mineral identification by such workers as Siebel (19), Winchell (20), Mitsche and Onitsch (21), Tertsch (22), Robertson and Van Meter (23), and Nakhla (24). Hardness values for a number of ore minerals have been obtained using Knoop and Vickers indenters, but these have not been employed systematically as an aid to ore mineral identification. The hardness testers previously used for mineragraphic studies have been either self-contained or designed for use with special microscopes, whereas the present instrument can be fitted to any standard ore microscope as an accessory (Fig. 4).

G.K.N. Micro-Indentation Hardness Tester

The tester was developed at the research laboratories of Guest Keen and Nettlefolds, Ltd., and is manufactured by Associated Automation, Ltd., London. A square diamond pyramid with a 136° included angle between opposite faces is mounted on a counterpoised beam suspended by two crossed flat springs. The beam is secured to a lower rotating plate which also carries two centralizing objective holders (Fig. 5). The instrument is secured to the microscope by an adapter attached to the upper mounting plate.

Operation of the Tester.—To test the hardness of a mineral grain the indenter is rotated into position in place of an objective and the sub-stage raised until the polished surface is just clear of the diamond pyramid. The fine focusing control of the microscope is used to lower the indenter gently until it just rests on the mineral surface. The application of the full load is indicated electrically by a miniature neon lamp which is arranged to be in circuit when the beam is in balance. When the specimen takes the load the circuit is broken and the neon lamp glows with a much reduced intensity. Having made the indentation (Fig. 6) the pyramid is raised, the objective brought back into position, and the indentation orientated by means of a mechanical stage for measurement with a screw-micrometer eyepiece. The whole operation takes about 40 seconds to complete and after some experience three or four identations can be made and measured in 2 minutes.

Hardness Value.—The hardness value which is a function of load over area can be calculated from the length of the diagonals by use of the formula

$$H = \frac{2P\mathrm{Sin}\theta}{D^2}$$

where H is the diamond pyramid hardness

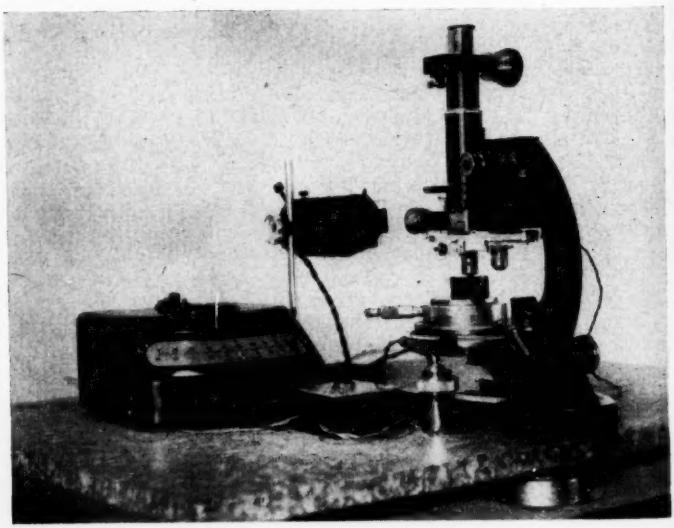


Fig. 4.—Ore Microscope, with Micro-Hardness Tester and Electric-Cell Photometer Attachment on Shock-Proof Base Plate.

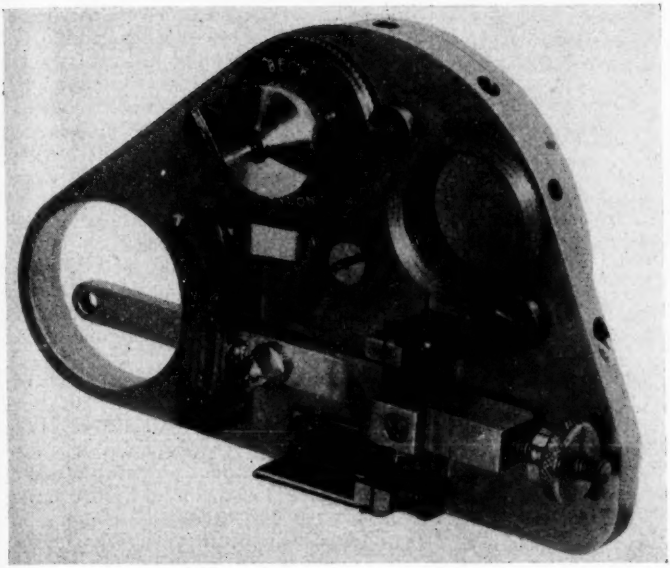


Fig. 5.—Lower Rotating Plate of Micro-Hardness Tester :
Showing beam with indenter and objective holders.

number, P the load in kilograms, D the length of the diagonal in millimetres, and θ is half the included angle between opposite pyramid faces. In the case of a 136° indenter $2\text{Sin}\theta = 1{\cdot}854$ so that :—

$$H = \frac{1{\cdot}854P}{D^2}$$

For convenience in use the hardness number is not calculated each time but read off tables which give solutions to the above equation for standard loads.

Discussion of Results

Reproducibility.—A number of tests were made on a series of mineral specimens to check the reproducibility over the range of hardness commonly encountered in ore minerals. Six minerals, two soft, three medium-hard, and one hard were chosen and repeat measurements carried out on each using a load of 100 g. The indentations were made on the same crystal in the same orientation in each case, thus eliminating differences due to causes other than instrument precision and personal element in measurement. The results given in Table 5 indicate that the accuracy is better than 5%.

Variations with Locality.—Specimens of the same mineral from different localities were tested to see if slight changes in composition might result in variations in hardness number (Table 6). Isotropic minerals were chosen to avoid differences due to crystallographic orientation but one anisotropic mineral, namely chalcopyrite, was included. Only in the case of galena was there any appreciable difference in the standard deviation compared with that of measurements carried out on a single crystal (Table 5). It therefore seems reasonable to expect that minor compositional variations are not likely to give variations in hardness values in excess of the accuracy of the determination. Further tests are, however, being made on this aspect of hardness measurements.

Hardness Values Obtained on Randomly Orientated Mineral Sections.—Just over 100 ore minerals have been tested to date. These range from graphite with a Vickers hardness number of 12 to chromite with a value of

Table 5

Standard Deviations for a Series of Hardness Tests on Minerals

Mineral species	*Number of observations*	*Mean*	*Standard deviation*	*Standard deviation, %*
Galena	40	76	1·6	2·1
Chalcopyrite	40	192	5	2·6
Magnetite	40	558	12	2·1
Pitchblende	37	722	37	4·8
Davidite	61	727	30	4·1
Pyrite	36	1,201	53	4·7

Table 6

Variation of Hardness Values in the Same Mineral from Different Localities

Mineral species	*Locality*	*Hardness (mean)*	*Standard deviation %*
Galena	St. Aubyn and Grylls Mine, Cornwall		
,,	Urgeiriça, Portugal	76	4·7
,,	Kirkudbright, Scotland		
,,	Isle of Man		
Chalcopyrite	Bushman Mine, Bechuanaland		
,,	Mary Kathleen Mine, Australia		
,,	West Wheal Basset, Cornwall	194	3·6
,,	Austria		
,,	Cornwall		
,,	Ontario, Canada		
,,	Rum Jungle, Australia		
Magnetite	Braastad, Norway		
,,	Arendal, Norway		
,,	Swedish Lapland	560	3·2
,,	Chota Nagpur, India		
,,	Chibazi, N. Rhodesia		
,,	Turkey		
Pitchblende	Wheal Trenwith, Cornwall		
,,	Trewavas Head, Cornwall		
,,	Kingswood Mine, Devon	720	4·2
,,	Azegour, Morocco		
,,	Mary Kathleen, Australia		
Davidite	Tete, Mozambique		
,,	Billeroo, South Australia	745	3·5
,,	Tambani, Nyasaland		
Pyrite	Fiji		
,,	Rio Marina, Elba		
,,	Facebaya, Transylvania	1,165	4·5
,,	French Creek, Penn., U.S.A.		
,,	Blind River, Canada		

1,200 (Table 7). As in the case of the reflectivity measurements, an attempt has been made to obtain maximum and minimum values by making measurements on crystals in all possible orientations, but because of lack of material it is unlikely that the full range will have been covered in every instance. The values quoted are therefore regarded as tentative and subject to revision when more determinations have been made.

Quality and Shape of Indentations.—The nature of the indentations in some instances is of diagnostic value. For example, the hardness values obtained on some sections of chalcopyrite overlap those of pentlandite, but the indentations are quite distinct. In the former mineral the edges are nearly straight; in the latter they are markedly concave (Table 7). The shapes of indentations observed in minerals are analogous to those encountered in metals (25). Straight edges, indicating perfect deformation and no appreciable elastic recovery, are sometimes observed, though the majority of the ore minerals give indentations with slightly concave margins. In addition to pentlandite concavity of the margins is pronounced in minerals such as blende, jamesonite, and hessite.

The indentations produced in prismatic sections of chalcocite, covelline, ilmenite, and hausmannite vary with the orientation of the mineral relative to the indenter. In one direction the indentations have two opposite sides concave and two convex; on rotation through 45°, however, the indentations are elongate or kite-shaped with slightly concave edges. In such instances as this fairly reliable hardness values are obtained by averaging the measurements obtained for the two diagonals. Generally speaking the indentations in ore minerals are well-defined and are easy to measure with a high degree of accuracy. Only in some instances such as with graphite and molybdenite have the diagonals proved to be really ill-defined. Slight surface cracking around otherwise good indentations were observed in about 20 minerals and in such instances only the more clearly defined and least fractured diagonal was measured. In the case of some hard friable minerals like pyrite, uraninite, and coronadite the indentations were obscured by flakes and cracks making them difficult to measure, but surprisingly few minerals were so brittle under the 100 g. load as to give really poor indentations. The ability of the G.K.N. instrument to give good indentations with most ore minerals is of considerable importance since the major drawback of the standard metal test instruments such as the Rockwell, Brinell, and Vickers testers, which use loads of a kilogram or more, is that the minerals shatter and yield no precise hardness data.

Marked Variations in Hardness with Crystal Orientation.—Although no attempt has yet been made to relate variations in hardness to precise crystallographic directions it has been observed that some minerals show marked

Table 7

Minerals Arranged in Order of Increasing Vickers Hardness Numbers

Number of localities	*Mineral species*	*Mean*	*Range*	*Quality of indentation**	*Remarks*
2	Graphite	12	12	p.	
3	Molybdenite	17	16–19	p.	⊥ to cleavage
		23	21–28		∥ to cleavage
1	Bismuth	18	16–19	p.cv.	
1	Tellurbismuth	21	20–21	sf.cv.	
2	Argentite	24	20–30	p.cc.	
1	Hessite	33	28–41	p.cc.	
1	Orpiment	38	23–52	sf.cc.	
1	Electrum	40	34–44	p.cc.	
2	Stromeyerite	41	38–44	p.	
1	Altaite	51	48–57	p.	
2	Gold	51	50–52	p.cv.	
2	Silver	53	48–63	p.cv.	
1	Realgar	56	53–60	p.	
1	Digenite	61	56–67	p.cc.	
1	Arsenic	63	57–69	p.	
3	Pyrargyrite	71	50–97	sf.cc.	⊥ to cleavage
		106	98–126		∥ to cleavage
3	Covelline	72	69–78	sf.cc., cv.	
4	Galena	76	71–84	p.	
2	Pyrolusite	76	76	sf.cc.	Average hardness ⊥ to fibres
		252	252		Average hardness ∥ to fibres
		279	256–346		Isotropic sections
		292	225–405		Microcrystalline
2	Stibnite	77	42–109	p.	
1	Chalcophanite	81	71–85	sf.	⊥ to cleavage
		124	103–165		∥ to cleavage
		133	110–178		Isotropic sections
4	Chalcocite	84	68–98	p.cc., cv.	
1	Antimony	89	83–99	p.	
1	Jamesonite	99	96–105	p.cc.	Granular allotriomorphic sections
		113	105–121		Prismatic sections
4	Bornite	103	97–105	p.cc.	
2	Bismuthinite	107	92–119	p.	
2	Miargyrite	110	104–123	sf.cc.	
1	Sylvanite	110	102–125	p.	
1	Kobellite	116	69–173	p.	
1	Proustite	123	109–135	p.	
1	Platinum	126	125–127		
1	Copper	134	120–143	p.cv.	
1	Naumannite	148	115–185	p.cc.	
1	Zincite	154	150–157	p.cc.	⊥ to cleavage
		304	295–318		∥ to cleavage
1	Pearceite	160	153–164	sf.cv.	
3	Enargite	160	133–185	sf.	⊥ to cleavage
		272	245–346		∥ to cleavage
2	Boulangerite	166	157–183	p.	
1	Dyscrasite	167	162–178	p.	
1	Berthierite	171	155–185	sf.	
1	Zinkenite	178	162–207	sf.	
1	Emplectite	191	168–213	p.cc.	∥ to elongation
		222	197–238		⊥ to elongation
1	Bournonite	192	185–199	sf.	
7	Chalcopyrite	194	186–219	p.	
5	Blende	198	186–209	p.cc.	
2	Cuprite	199	192–218	p.	
2	Stannite	210	197–221	sf.	
2	Cubanite	213	199–228	sf.	
3	Pentlandite	215	202–230	p.cc.	
1	Tenorite	236	209–254	p.cc.	
1	Millerite	236	225–256	p.	Isotropic sections
		254	235–280		∥ to elongation
		348	318–376		⊥ to elongation
5	Pyrrhotine	248	230–259	p.	Anisotropic sections
		303	280–318		Isotropic sections
1	Alabandite	251	240–266	p.cc.	

Table 7 (*Continued*)

Number of localities	*Mineral species*	*Mean*	*Range*	*Quality of indentation**	*Remarks*
1	Coffinite	258	236–333	p.	
2	Chalcostibite	276	264–285	sf.	
3	Niccolite	336	328–348	p.	Anisotropic sections
		446	433–455		Isotropic sections
1	Tennanite	338	320–361	p.	
1	Freibergite	345	317–375	sf.	
2	Scheelite	348	285–429	..	
4	Tetrahedrite	351	328–367	sf.	
1	Famatinite	363	333–397	sf.	
3	Wolframite	373	357–394	p.cc.	
2	Manganite	410	367–459	p.	
1	Carrollite	463	351–566	p.	
6	Löllingite	486	421–556	p.	⊥ to elongation
		825	739–920		∥ to elongation
3	Siegenite	524	503–533	sf.	
1	Ullmannite	525	498–542	sf.	
3	Betafite	525	503–560	p.	
4	Ilmenite	536	519–553	sf.cc., cv.	Possible differences in composition
		681	659–703		
5	Goethite	554	525–620	sf.	Microcrystalline
		803	772–824		Coarsely crystalline
6	Magnetite	560	530–599	p.	
1	Breithauptite	563	542–584	p.	
1	Psilomelane	572	503–627	p.cc.	
1	Hausmannite	587	541–613	sf.cc., cv.	
2	Braunite	595	584–605	p.	
2	Pyrochlore	613	572–665	sf.	
2	Hollandite	620	560–724	p.	
5	Skutterudite	653	589–724	p.	
1	Gersdorffite	698	665–743	sf.	
2	Maucherite	704	685–724	p.	
3	Euxenite	707	599–782	p.	
2	Rammelsbergite	712	687–778	sf.	
4	Brannerite	720	710–730	p.	
5	Pitchblende	720	673–803	f.	Fresh specimens, oxidation produces marked decrease in hardness.
1	Lepidocrocite	724	690–782	sf.	
1	Jacobsite	734	724–745	p.	
3	Davidite	745	707–803	p.	
5	Hematite	755	739–822	sf.	Microcrystalline
		1,009	920–1,062		Coarsely crystalline
1	Pararammelsbergite	772	762–803	sf.	
1	Coronadite	784	767–813	f.	
3	Columbite-tantalite	803	724–882	p.	
1	Uraninite	808	782–839	f.	
1	Maghemite	946	894–988	p.	
1	Bixbyite	1,018	1,003–1,033	p.	
3	Thorianite	1,918	988–1,115	f.	
2	Cassiterite	1,053	1 027–1,075	p.	
3	Arsenopyrite	1,094	1,048–1,127	sf.	
1	Bravoite	1,097	1,003–1,288	sf.	
4	Marcasite	1,113	941–1,288	f.	
1	Glaucodot	1,124	1,071–1,166	sf.	
2	Rutile	1,139	1,074–1,210	p.	
5	Pyrite	1,165	1,027–1,240	f.	
2	Cobaltite	1,200	1,176–1,226	sf.	
2	Chromite	1,206	1,195–1,210	p.	

* p = perfect, sf. = slightly fractured, f. = fractured ; cc. = concave and cv. = convex refer to the shape of the edges of the indentation where curvature is marked.

directional variations. This is particularly noticeable in fibrous and prismatic crystals of löllingite, pyrolusite, enargite, zincite, millerite, and niccolite. For such minerals hardness values are given both parallel and perpendicular to the crystal elongation.

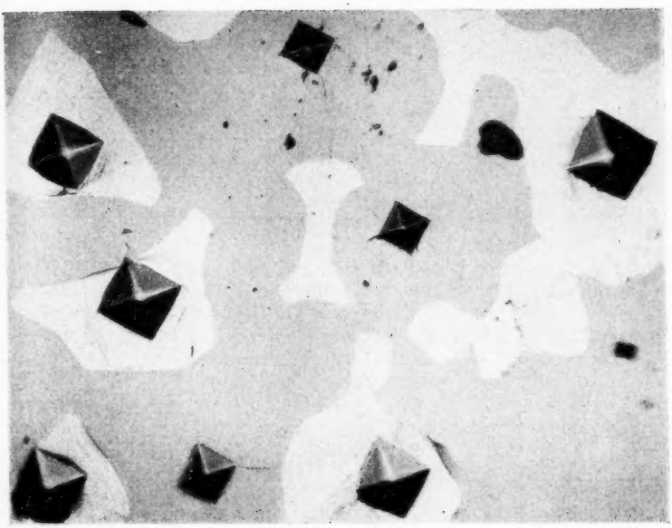


Fig. 6.—Photomicrograph Showing Indentation in Galena (light grey) and Boulangerite (grey).

Differences Due to Degree of Crystallinity and Composition.—Variations in hardness due to degree of crystallinity were noted particularly in hematite and goethite, the values for the microcrystalline varieties being only about 70% of those obtained on coarsely crystalline material. A study has not yet been made of hardness and reflectivity variation in such solid solution series as skutterudites and safflorite-löllingite, or of variations in these constants for blende with different contents of iron. However, it seems probable that precise reflectivity and hardness values will give indications of compositional differences at present only determinable by chemical analysis.

(*To be concluded*)

The Uranium Minerals of Katanga

The uranium deposit of Shinkolobwe in the Belgian Congo has long been known not only as the greatest high-grade ore occurrence of its kind but also as the type locality of an exceptional number of rare minerals of surpassing beauty. The secondary uranium compounds derived from the alteration of the primary uraninite include some of the most arresting species of the mineral kingdom, presenting a vivid spectrum of colours unrivalled in inorganic nature. Specimens are prize exhibits in museums throughout the world, but, despite the meritorious efforts of the mine geologists to ensure that the finer and rarer minerals are saved, complete representations of this unique assemblage cannot be seen outside Belgium and the Belgian Congo.

Unusual interest therefore attaches to a collection of 27 fine coloured reproductions of these minerals (one plate to each species) produced, under the title "Minéraux d'Uranium du Haut Katanga," by Les Amis du Musée Royal du Congo Belge. The minerals have been photographed by M. Destas of the French Commissariat à l'Énergie Atomique, whose work in this sphere of colour photography is unexcelled and for each species particulars of its physical properties, distribution, and mode of occurrence have been furnished by Dr. C. Guillemin. An introductory chapter by Dr. J. F. Vaes, mineralogist of the Union Minière, briefly describes the mode of formation and the associations of the species illustrated. The Musée du Congo Belge (Tervuren, Belgium) is to be congratulated on producing a work (price 240 francs) which is unique amid the present spate of publications on uranium.

C. F. D.

Rapid Sinking in Coal Measures

An outline of methods in use at Parkside Colliery

A new colliery, known as Parkside, is being developed at Newton-le-Willows, Lancashire, by the National Coal Board. Work on the surface installations is proceeding according to schedule and substantial progress is being made with the sinking of two 24-ft. diameter mass concrete-lined shafts. At the site shaft sinking is being carried out by Kinnear Moodie and Co., Ltd., who have retained the services of the Roberts Construction Co., Ltd., to advise upon the application of South African techniques to the particular conditions of the area. The shafts will eventually be 2,595 ft. deep and are carried through 10 ft. of glacial drift, 30 ft. of Manchester marl, and 80 ft. of barren Upper Coal Measures, the remainder being in the Coal Measures proper. Major seams cut include the Crombouke, Rams, Upper and Lower Floridas, Wigan 4 ft., and the Trencherbone. The area is bounded by the Warburton fault to the north and the Winwick fault to the west.

High-speed shaft sinking, even more than high-speed driving, requires the successful co-ordination of all phases of the working routine and in the construction of these circular shafts the contractors have attained a high degree of integration, dividing operations into a cycle of five phases. The success of the integration of these phases is reflected in the achievements of recent months, when over 260 ft. of sinkage have been achieved in each shaft, the best advance being made in No. 1 shaft in September, when the progress made amounted to 310 ft., of which 306 ft. was lined. The sinking routine is governed by the necessity to keep the minimum length of shaft wall exposed at one time and thus follows on shutter advances of 15 ft. brought up closely behind the face.

The shafts, as already noted, are 24 ft. finished internal diameter and are mass concrete lined, this lining following closely behind the face. The outstanding features in the shaft-sinking routine include the use of a pneumatically-operated cactus grab loading kibbles at the rate of 100 tons per hour and contributing to this high mucking rate is a lazy chain method of dumping the kibbles, or " hoppitts," at the shaft top, while the use of parallel circuit firing substantially reduces the time lost due to rounds hanging up due to damaged detonator leads.

The main equipment in each shaft consists of a three-deck circular stage or scaffolding of 22 ft. diameter, the height of this unit being 32 ft. 6 in., with 15 ft. clearance between decks. The stage is raised or lowered to its required position in the shaft by four in line $3\frac{7}{8}$-in. circumference locked-coil ropes reeled on a four-drum capstan hoist, steam driven, and capable of raising a total load of 40 tons at 10 ft. per min. when operating at 80 p.s.i. The capstan ropes serve as guide ropes and carry the cross-heads which steady the hoppits through the shaft. At any working position the weight of the scaffold is transferred partially from the capstan ropes to eight $1\frac{1}{8}$-in. diameter wall slings 150 ft. in length anchored to 2-in. pins, which fit into 2-in. pipe sockets cast into the concrete. On the bottom deck of this stage the termination to the stage manifold and air and water connexions for the grab, drills, and other pneumatic equipment are located. The central deck carries six 5-ton hand-operated winches for hoisting or lowering the shutter assembly and an " octopus " distribution box from which four 6-in. diameter hoses which supply concrete to the shuttering are led off. A lighting and bell distribution panel are also located here, together with a telephone connecting to the shaft bottom and surface. The grab assembly which pivots concentrically around the shaft is located below the bottom deck of the scaffold and is supported by an inner and an outer monorail located on strengthened sections of the scaffold. Its main framework comprises an operator's cabin and a rectangular base on which a 25-b.h.p. Pikrose air-operated hoist is located for raising and lowering the 20-cu.ft. pneumatically-operated Priestman cactus grab, which is able to transverse radially

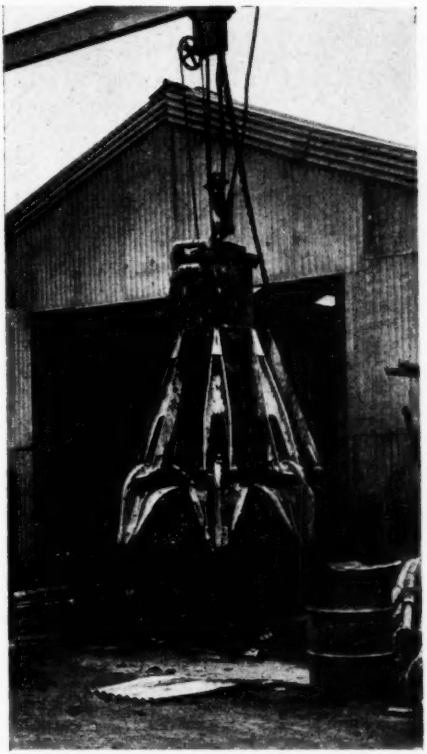
across the shaft. The operator's cabin, centrally situated, pivots with the assembly and affords a clear view of the shaft sump and ensures rapid and safe loading of the hoppits.

Main services in each shaft are provided by a 6-in. air column, a 2-in. water line, a 24-in. ventilation pipe, a 6-in. pipe for concrete, a 1½-in. cementation range, and a 4-in. rising main as standby for pumping purposes if required. Signalling, telephone, and blasting cables are also installed. The latter terminates when not in use at a point some 150 ft. from the face and is isolated at surface.

The double-shelled steel shuttering used to support the emplacement of the shaft lining consists of five circular rings the lowest being known as the kerb shutter. This is of extremely strong construction, being of mild steel strengthened by a bevelled section. The base of the bevel carries cotter pins secured inside the shutter by a nut and linking below with a mild-steel joist. This arrangement allows scribing boards which form a " soffitt " to be placed into position between the base of the shutter and the joist held securely by a wedge driven into the pins. The kerb section is 2 ft. 6 in. in height and is followed by three sections each 3 ft. 9 in. high and a matching section of 1 ft. 6 in. giving an overlap of 3 in. at the bevelled section of the concrete.

Shutter sections are lowered into position by the six hand winches mounted on the centre deck and the weight is then transferred to eight slings suspended from sockets formed for this purpose in the shaft lining. The kerb section is adjusted for exact setting with plumb lines and steel tapes suspended from survey points in the shaft. It is 25,000 lb. in weight. The sections are carried down by the removal of a 15-in. wedge piece which is unbolted and withdrawn allowing the shutter to collapse inwards before lowering for the next lift of concrete. The sockets from which the sections are suspended are formed by inserting pipes into the mass concrete at an angle of 10° from the horizontal, these pipes later accommodating pins which have eyes from which the slings are hung. Safety pins, with eyes through which the sling may pass, are also provided below the main pins and the sling carries over-riders above these safety pins which engage in the event of failure of the main pin.

The kibble or " hoppits " into which the grab loads are of 5-ton capacity and four are used in each shaft, two being loaded at the shaft bottom whilst two are in transit. The " lazy chain " method, by which they are dumped at surface, provides an extremely quick method of discharge and return, maximum safety being assured by a system of doors. The shaft headgear is fitted with pneumatically operated doors at ground level which close horizontally after a kibble has been hoisted to the shaft top where a chain is attached to a lug at the base of the kibble. Simultaneously with the closing of the shaft doors a pneumatic ram lowers a chute or drawbridge under the kibble which is then lowered, discharging its load as it tips forward due to the base being firmly held by the chain. Discharge is into two 15-cu. yd. capacity hoppers and the broken rock is then taken away to dump by Muir Hill dumpers of 4½ cu. yd. capacity.



Grab under Test after Service.

At the shaft bottom the grab moves round to a position under the outgoing kibble left there. After this is filled the grab swings to a mid-position in the shaft and awaits the

downcoming empty kibble on the opposite side. The downcoming kibble is spotted by the crew in the sump, who swing it clear of any obstruction and as the kibble at the shaft top comes to rest at the top of the wind the corresponding slack in the winding rope at the shaft bottom allows the slings to be detached. When the chain has been attached to the kibble at the top of the shaft and the kibble lowered to its dumping position the cables in the shaft bottom are raised by a corresponding amount and are then swung over the full kibble and the braces attached to it to await hoisting. A crosspiece which overrides the kibble coupling comes into action as soon as each kibble has passed through the stage, each crosspiece running in two of the cables by which the stage is suspended.

The shaft-sinking routine falls into five separate stages and is based upon a 15-ft. shutter advance after every second or third round. Thus after a round has been fired and levelled giving room for a further ring of concrete the stage is lowered, steel tapes are hung on their brackets, unreeled as the stage moves down, and are left ready for levelling the kerb. The scribing boards of the kerb ring are loosened and retracted and the insert holding the kerb rigid is withdrawn after the winch ropes have been applied. The kerb is then lowered 15 ft. and the weight of the ring is transferred to the wall slings. When the kerb shutter is dropped the 15-in. wedge insert is immediately replaced and bolted firmly and the shutter is plumbed to concentricity and levelled by means of the tapes and is secured by timber distance pieces, after which the scribing boards are placed securely against the sidewall and the scribing ring tensioned up. While this work is in progress extension hoses are lowered through the stage and the "Octopus" hoses which carry the concrete are fitted into the spigots. The scribing boards are fitted, paper from concrete sacks being used to plug any crevices. Concrete is then passed down the 6-in. diameter pipe from surface to the distribution box on the centre deck. A kettle or boiling box is sited in the shaft at the bottom of the line and this has been found to overcome any tendency on the part of the concrete to segregate. The general mix used for the lining is 0·600 water/cement ratio, resulting in an average compressive strength of 2,800 lb./sq. in. at 7 days. Owing to the frequency of the shutter advance very rapid hardening is required and to effect this 2% by weight of calcium chloride to cement is added in 3-gal. solutions to each cu. yd. of concrete in the weigh batching plant at surface. Completely effective vibration during placing is essential as, when set, the lining must be of uniform compressive strength to deal with the ring stress induced. Vibration is carried out by Consolidated Pneumatic type 325 poker vibrators having a vibrating capacity of some 40 cu. yd. to 50 cu. yd. per hour at an air consumption of 50 c.f.m. at 90 p.s.i.

When the first ring of concrete has been poured the balance of the shuttering is lowered and at the same time the temporary support rings fitted during a previous shift to prevent scaling of the shaft wall are removed. In the second stage the scaffold or circular stage is raised a short distance up the shaft to the mucking position and is secured to wall slings. After the stage has again been centred and jacked firmly to the sides of the shaft mucking or "lashing" recommences and is normally completed in some 3½ hr. When this is effected the exposed sump is blown over by compressed air from a 2-in. flexible hose and prepared for drilling operations. The scaffold is then lowered and the third stage consists of drilling and charging, completing concreting operations, and flushing the concrete pipes.

Where water seepage is encountered, as for example in the first 600 ft. of sinking, cementation holes are drilled usually some 105 ft. in length using Consolidated Pneumatic type 59 sinker drills. Grouting is injected from an Evans Cornish ram-type pump and to ensure that the grouting is of uniform consistency before injection it is mixed in a drum containing rotating paddles operated by a Consolidated Pneumatic type 350R air drill. Drilling of the wedge cut and round is carried out with Holman "Silver Three" drills using ⅞-in. hexagonal steel and 1⅝-in. detachable tungsten carbide-tipped chisel bits.

When completed the round is charged with 220 lb. polar ammon. gelignite, standard I.C.I. ½-sec. delay detonators being used. These are fired in a parallel circuit connected up to inner and outer buss bars, these comprising two 7 by 0·036 diameter strand wires. The explosive ratio of 2·75 lb./cu. yd. ensures maximum fragmentation and normally the round pulls for the whole of the 6 ft. drilled, together with a little overbreak. A high degree of fragmentation with the elimination of any large boulders is essential to efficient working of the grab.

Site Layout Servicing Two Shafts.

Smoke clearance normally takes some 30 min., ventilation in the shaft being provided by two Woods of Colchester Aerofoil axial-flow mine fans. The fans are four stage units and are powered by Woods flameproof motors, Buxton certified for groups I and II applications. Each four-stage unit is designed to give an output of 11,250 c.f.m. through 2,550 ft. of 24-in. diameter steel duct, power consumption being approximately 17 h.p. per motor. Direction flameproof starters with "Forward–Off–Reverse" isolators are supplied by Woods for each motor, these being manufactured by the Belmos Co., Ltd.

When smoke clearance is complete the fourth stage begins and this consists of lowering the scaffold again followed by an examination of the shaft wall which is then dressed down. After scaling has been carried out mucking proceeds and at the same time temporary steel support rings are fitted to the sides of the shaft as the muck is lowered. Finally the sump is blown over and drilling proceeds in a fifth stage followed by charging and firing to complete the cycle. The face crew on each shift comprises 12 men and a foreman in the sump and a concreting crew of eight, covering a face advance of up to 300 ft. per month.

Compressed air is used widely throughout the operation and to supply the large volume required a battery of eight Consolidated Pneumatic class T slow-speed, horizontal, water-cooled compressors with a total output of 4,980 c.f.m. at 100 p.s.i. are installed at surface, four of the units being type TB single-stage compressors converted from low-pressure operation by a substitution of cylinders. Rated output of the type TB unit when used for this duty is 500 c.f.m. at 100 p.s.i. three of the compressors being powered by Brush motors developing 130 b.h.p. at 979 r.p.m., the fourth being a B.T.H. motor capable of developing 160 b.h.p. at 1,470 r.p.m. The remaining units are four Consolidated Pneumatic type TCB two-stage compressors each delivering 745 c.f.m. at 300 r.p.m. Power units are Brush 130-b.h.p. motors.

Other services at surface include a central weighbatching plant by Millars Machinery Co., Ltd. The mixing plant comprises two Winget ½-cu. yd. drum mixers and one Millars 1-cu. yd. mixer. The latter, a 28 NT unit, is the largest non-tilting drum-type mixer in the Millars range. The batching plant consists of three separate assemblies, one to each mixer and each unit contains a central cement compartment of 30 tons capacity and two aggregate compartments each of 15 cu. yd. capacity. Aggregate is loaded to the hoppers from a stockpile by a Smith steam crane, while cement is received in tankers and is pneumatically conveyed to storage, delivery being in bulk from the Ribblesdale Cement Co., Ltd.

These batchers have a combined output of 40 cu. yd. per hr. and to enable concrete to be fed to either shaft at this rate two 24-in. Frederick Parker conveyors of 100-ft. length

are installed, each conveyor running the length of the batching plant installation and discharging to a hopper feeding the 6-in. line which services each shaft. Each batching unit is equipped with chutes which may be deflected to either conveyor, allowing considerable variation in feed rate according to requirements.

Ore-Dressing Notes

(13) *Lithium*

Australian Spodumene

A survey by Miss I. J. Bear, of the C.S.I.R.O., Melbourne, examines the current position on lithium extraction from Western Australian spodumene. This mineral, one of the most abundant of lithium sources, has a theoretical lithia content of 8% although, as it naturally occurs, it is rarely above 6%. The United States produces more than half the world's output and other extensive deposits occur in South-West Africa, Canada, and Sweden. There was at one time a strategic war shortage chiefly owing to lack of milling facilities but following the cessation of hostilities lithium ore was in over-production. The market has now more than recovered for while the war call was important for the production of lithium hydride (used to produce hydrogen) the peace applications include lubricating greases, alkaline storage batteries, air conditioning and refrigeration plants, ceramics, pharmacy, and welding.

Spodume ($Li_2O.Al_2O_3.4SiO_2$) is much used in the ceramic industry. It has a density of 3·15 and is fairly inert and hard. On heating to 1,050° C. it transforms to β-spodumene with a density of 2·4, a form readily pulverized. An earlier method for extracting lithium started with a high-temperature sinter with lime or a lime-gypsum mixture, the resulting calcine being leached with water and the lithium precipitated as carbonate. This method was succeeded by a base-exchange process with the finely-ground ore being treated by excess potassium sulphate which displaced the lithium ion. The lithium sulphate together with any residual potassium sulphate was leached away. The method was relatively uneconomic because of the loss of potassium sulphate. Methods used in research on spodumene ore from Mount Marion, which lies some 20 miles south-west of Kalgoorlie, in Western Australia, are given by Miss Bear in an article in the *Chemical Engineering and Mining Review* of February 15 last.

The sulphuric ion exchange method now used commercially by one company depends on the treatment by sulphuric acid of β-spodumene. At a critical temperature between 250° and 300° C. hydrogen ions are substituted for the lithium ions, the aluminium not being affected. The reaction is—

$$Li_2O.Al_2O_3.4SiO_2 + H_2SO_4 = H_2O.Al_2O_3\ 4SiO_2. + \underset{Li_2SO_4}{}$$

The acid roasting period is given as 10 min., the resulting lithium sulphate being leached, purified, and precipitated as carbonate. Using this method in the laboratory a carbonate of 82% purity was obtained which could be improved to 96·6% by rewashing; the total extraction was of the order of 95%. In another commercial process rotary kilns are used to decrepitate and acid-roast the ore. The product is leached with sulphuric acid and neutralized by limestone, following which a sodium carbonate solution is used to precipitate the lithium, the lithium carbonate slurry being centrifuged repulped and cleaned. In another process for spodumene a better yield has been obtained by using a gypsum-limestone mixture and sintering for 2 hours at 1,050° to 1,150° C. Pilot operations by an American company indicated that the process would be difficult to control.

The author's conclusion is drawn from a number of laboratory experiments and a survey of the literature. It is to the general effect that of the numerous methods available the final choice of a process would depend on availability of the acting materials and costs of transport. These considerations apart, the sulphuric acid ion-exchange method appears most efficient. The growing demand and new uses for lithium-bearing materials is likely to continue.

Ellestad and Clarke (*Trans. A.I.M.E.*, Dec., 1955) have also given a useful survey, together with an outline of some commercial processes. That used by the Lithium Corporation starts with conversion of natural spodumene to β-spodumene by kilning at 1,100° C. Next comes grinding followed by kilning at 250° C. for 10 min. with excess sulphuric acid. Advantages claimed include easier mixing with H_2SO_4 than with solid reagents; satisfactory reaction at coarse grind owing to absorption of acid by porous β-spodumene;

shortness of kilning times; simplicity of water leach; direct extraction from run-of-mine ore. In one concentrator in Dakota (Munson and Clarke, *Trans. A.I.M.E.*, Nov., 1955) heavy-media treatment at a bath density of 2·7 is reported. In another flotation is practised with an anionic fatty acid in treated water after thorough desliming.

(14) *Gold*

The Hollinger Flow-Sheet

The famous Hollinger mine began pilot treatment in 1910 and a 300-ton mill started in 1912. Production rose to 6,000 tons daily in 1927, but following extensive changes this has now been progressively reduced to the current figure of 3,000 tons with over 97% gold recovery. At the start stamping in cyanide was followed by pebble-mills closed with rake classifiers and special treatment of a pyritic concentrate caught on shaking tables. This basic method, though with newer types of machine, is still visible in the flow-sheet (Fig. 1). Hollinger has made outstanding contributions to the literature of mineral dressing and has always been alive to the value of what to-day is called "operational research." Its 10,000-ton circular ore-bin is a landmark. The ore which carries 4% pyrite and some scheelite in a quartz-schist mixture is crushed underground to *minus* 6 in. and finished to *minus* $\frac{3}{16}$ in. before grinding in cyanide to 60% *minus* 200 mesh; 45% of the gold is extracted in the grinding circuit. Classifier overflow is distributed over 90 double-deck shaking tables, whence one-sixth of the feed is removed as a low-grade pyritic concentrate carrying two-thirds of the pyrite and four-fifths of the residual gold. This is ground to 80% *minus* 325 mesh, thickened to 55% solids and agitated for 24 hr. to 36 hr. in rake agitators. It then joins the thickened table tails for a further 16-hr. agitation in Pachucas. Final stripping is done by a split between filtration and counter-current decantation.[1]

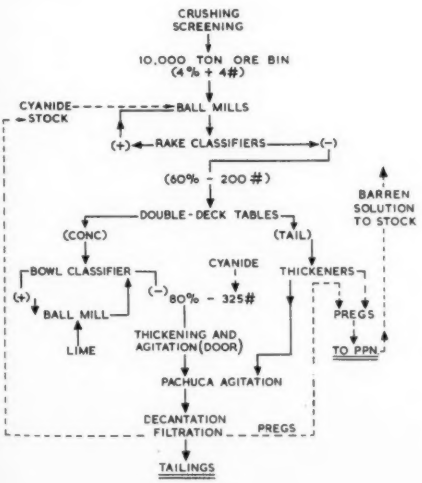


Fig. 1.

(15) *Leaching*

Use of Bacteria

Mineral dressing continues to increase its methods of attack. A new U.S. Patent has been granted which depends on the use of bacteria in the leaching of sulphide and thio-sulphate ores. Several strains of bacteria have the property of oxidizing iron and can live in fairly high concentrations of dissolved minerals, including copper, molybdenum, and zinc, to which they have developed specific qualities of endurance. The patented process requires the use and continuous regeneration of a leaching liquor containing ferric sulphate and sulphuric acid which has been inoculated with specific types of bacteria. Ferric sulphate and sulphuric acid have long been used for copper solution and for many years processes based on their reaction have been worked in the leaching of low-grade ores, scrap materials, and other mineral-containing substances. Part of the reaction requires that the ferric ion shall be changed to a ferrous ion during the leaching. The process has been limited in its economic application by the necessity for regenerating the spent leach liquor before its re-cycling—in other words, in restoring it from the ferrous to the ferric condition. This can be accelerated by the use of sulphur dioxide and of aeration but is a slow process.

The discovery of these iron-oxidizing bacteria promises to have an important effect on the cheap speeding up of the process of restoring ferrous to ferric ion; the general name has been given to these bacteria *thiobacillus ferroxidans*

Kennecott Copper, which has developed the process now patented, found these bacteria to exist in the Bingham and Chino

[1] Abstracted from a description by J. Blackshaw in 6th Commonwealth Congress volume "The Milling of Canadian Ores."

mines. They discovered a specific tolerance at Bingham for copper-containing water as against that mildly high in zinc. Successive generations of the bacteria were bred in cultures which developed the specificity and now new strains have been established. One, for zinc, has a tolerance of 17 g. per l. as compared to that of 150 parts per million in the original strain. The tolerance to copper has been increased to some 12,000 parts per million and probably this figure will be improved on. Aluminium, calcium, magnesium, manganese, and molybdenum are among the other bacteria thus far experimented with. These bacteria act directly on the pyrite and produce ferric sulphate and sulphuric acid. More important still, according to the patent, is the very rapid way in which they regenerate the leach solution without the need for involved procedures. Basically ferric sulphate and sulphuric acid, carrying suitable cultures, are applied to a sulphide for leaching purposes and a regeneration stage follows in which the bacteria-carrying solution is aerated and then recycled. This is applicable to heap leaching, batch leaching, or continuous work. The bacteria require an acid medium in order to do their oxidizing work. The regeneration proceeds according to the equation :—

$$2\,FeSO_4 + H_2SO_4 + \tfrac{1}{2}O_2 + \text{Bacteria} = Fe_2(SO_4)_3 + H_2O.$$

When necessary additional iron can be supplied as pyrite and iron can be removed from the solution circuit as necessary. Redwood tanks and launders must not be used in the work as these kill the bacteria. Temperatures must also be watched, the maximum practical operating temperature being of the order of 40° C. Optimum pH is of the order of 2 but reaction is excellent within the 1·5 to 2·5 range. Bacterial activity slows down below a pH of 1·5. Nutrients such as the nitrates or ammonium ions increase the initial activity of the bacteria and a nitrogen content of the order of 100 parts per million appears to be helpful. This, however, has not apparently been important in long-term operation.[1]

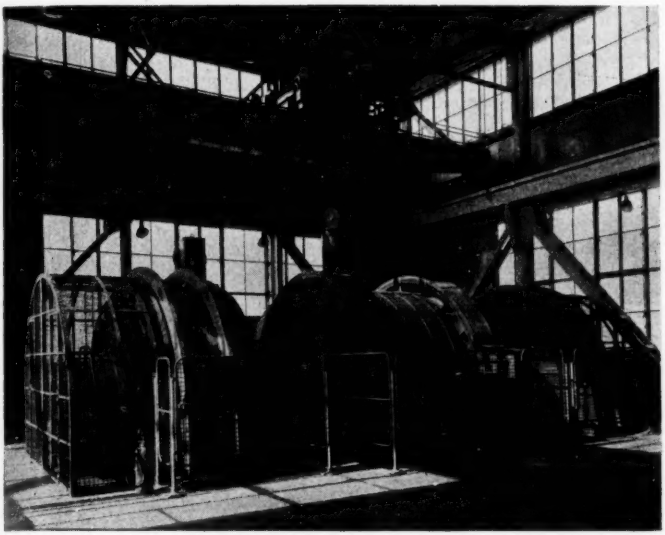
[1] *Engg Min. J.*, June 6, 1958.

Multi-Rope Friction Winder

As part of the National Coal Board's programme of reconstruction two electric winders for Nos. 2 and 3 shafts at Rufford colliery, in the East Midlands Division, have recently been commissioned. The driving motors and associated equipment for each winder are duplicates of the other and this feature is further to be extended in due course to embrace No. 1 shaft, which at present is steam driven but scheduled for conversion in the near future.

The installations now in service are the largest tower-mounted four-rope friction winders with directly-coupled motors in the United Kingdom and were supplied by the Metropolitan-Vickers Electrical Co., Ltd., in association with Markham and Co., Ltd., who were responsible for the mechanical parts under sub-contract. The architecture of the towers was undertaken by Young and Purves. The winder for No. 3 shaft, the first to be commissioned, is designed to raise skips in balance, each of 12 tons capacity, from a depth of 3,100 ft. at a maximum rope speed of 47·5 ft. per second and to give an output of 450 tons of coal per hour. The No. 2 shaft winder, with a single double-deck cage and counterweight, winds men, coal, and material from the same depth and serves all levels. The cage has a payload of 12 tons

Winder Tower.



Four-Rope Friction Winder.

or 100 men per wind. The normal rope speed is 49·25 ft. per second which may, if required, be increased to 55·4 ft. per second for winding coal to give an output of 280 tons per hour. The friction drum of each winder has a diameter of 12 ft. and the four $1\frac{1}{4}$-in. locked-coil ropes are independently attached to the conveyances to give a large margin of safety.

In both cases the winder is driven by two overhung d.c. motors, totalling 3,400 h.p., with shaftless hollow armatures of special design coupled directly to the shaft flanges on each side of the friction drum. This arrangement, in comparison with previous practise, offers a number of advantages including economy of space and weight.

A closed-loop control system is used, in conjunction with a Ward Leonard motor-generator set, for motor speed control and incorporates overriding acceleration, retardation, peak power demand, and current limiting features. Control is exercised through a static phase shifter in the grid circuit of a six anode mercury-arc rectifier for variable excitation of the generator shunt fields and, consequently, the motor armature voltage. A three-anode mercury-arc rectifier supplies a constant voltage for excitation of the motor fields; stand-by rectifiers are provided in each case. The winding cycles may be carried out automatically or under manual supervision.

The motor-generator sets are each driven by a 2,740-h.p., 11,000-V synchronous induction motor with automatically varied excitation for power factor correction and are housed in a separate building at ground level. This building will also ultimately contain identical equipment for the winder of the No. 1 shaft and switching arrangements will make the three sets functionally interchangeable—a valuable asset from both the safety and maintenance points of view.

Engineering Log

The idea that stresses arising out of movements in the earth's crust are " a source of power freely provided, if the natural laws governing it can be properly understood and respected " has been put forward by Dr. R. Kvapil of the office for Theoretical and Applied Mechanics in mining at Prague, where the subject is under close study. In this work the elasticity and strength of rocks are necessarily parts of the general problem. Dr. Kvapil and his colleagues have pursued investigations which have yielded fresh data on the destruction of rocks by cracking, splitting, and plastic deformation. This, in turn, has been useful in elaborating a theory of stress and as both a contribution to knowledge applicable in other branches of basic research (such as tectonics) and a

practical aid in working out support requirements, rock-drilling procedure, etc., in mines. It has also been found possible to reproduce some tectonic phenomena in laboratory models. The accompanying illustration shows how originally level strata of salt and gypsum, in a state of partial plasticity, have been transformed into a diaper ; at the same time the gypsum has been changed into anhydrite by a pressing out of the liquid element of cystallization. Dr. Kvapil's work suggests that there may well be possibilities of altering the mechanical and physical properties of rocks and that this will be another step in the process of simplifying and making safer the tasks of the mining engineer and the miner.

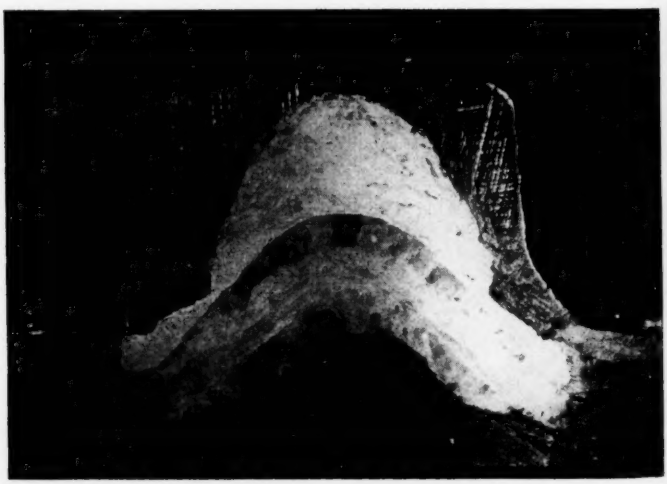
* * *

A new instrument for rescue work has been devised by the Fyr-Fyter Company of America. Known as the " Dualife," it is a portable air and/or oxygen mask and resuscitator unit providing protection to both rescuer and asphyxiation victim. The unit weighs 39 lb. and contains 52 cu. ft. of gas in two pressure cylinders, an adequate supply for 40 min. when the unit is used as a combination, or about an hour's individual service. The two small cylinders provide better balance for work in restricted spaces than would a single larger one. The face-piece and resuscitator valve are carried in a canvas pouch on the belt strap and can be attached to the regulator, as can the mask valve, by a coupling which can be quickly connected and disconnected. Built-in gauges supply accurate information on pressures to the wearer and an automatic warning bell gives notice of the need to replenish air or oxygen supplies. A Seeler valve in the resuscitator and a demand valve in the face-piece are said to ensure efficient operation. The unit may be used as a resuscitator alone in cases of drowning, electric shock, and the like. Comfortable positioning is achieved by means of quickly adjustable clamps on the nylon harness.[1]

* * *

The sticky soil of Hawaii presents unusual problems to tillage methods and the development of new plastic-coated ploughs holds promise for the future of more efficient tools than any devised before. The soil is highly colloidal and, consequently, non-abrasive, particularly when wet. Soil builds up almost immediately, even on polished steel, and converts the conventional mouldboard plough into a bulldozer. To overcome this problem the Pineapple Research Institute began experiments with a " Teflon " (TFE fluoro-carbon resin) surfacing, a Du-Pont plastic of proved efficacy in the shedding of sticky loads. The use of " Teflon " enabled mouldboard ploughs to operate and cut ploughing times by half ; tractors were able to operate in third instead of second gear. Further research produced an improvement in the surfacing methods and reduced wear and cost.

[1] *Comp. Air*, Dec., 1957.



Strata of Salt and Gypsum Transformed Under Pressure.

Instead of a solid sheet, with greatest wear on the wing of the mouldboard, the plastic was applied in strips so that worn sections could be replaced. Studies of other U.S. soils undertaken with a view to the application of such surfaces are now under way. The chief difficulty is the abrasive action of these much less colloidal soils, which usually contain sand not found in Hawaii. Combinations of plastic with other substances and the addition of ferric oxide to the compound gives higher strength and resistance to abrasion and it is hoped that some economies can be achieved in other areas as a result.[1]

* * *

Physicists at Duke University, North Carolina, have succeeded in building the first known liquid helium bubble chamber; similar chambers are planned by Oxford University and the University of Rome, as well as by another American institution, the Washington University. Drs. Martin M. Block and William M. Fairbank stated that the new chamber at Duke University was designed as a research tool in studying atomic nuclei blasted apart by high-energy bombardment. The unit differs by its use of helium instead of hydrogen from similar research units. Liquid helium is expanded suddenly in volume. This produces a state of instability in which the helium is ready for boiling, but lacks centres around which bubbles can form. The introduction of charged particles causes ionization, resulting in the formation of bubbles in the wake of the moving nuclear particles. The trail can then be photographed and an accurate record of the track of the particle obtained. Duke University helium bubble chamber operates at a temperature of about 453° below zero Fahrenheit. This is only a few degrees above absolute zero, or the lowest obtainable temperature. [2]

* * *

The world's known resources of commercial helium are confined to a small belt of country running through Utah, New Mexico, Oklahoma, Texas, and Kansas in the United States. This strategic material occurs in sufficient concentration to merit extraction in the natural gasfields in these areas only. The fields are expected to be exhausted within 20 years and at present only some 10% of the gas flowing from the wells is being salvaged. Its main use is in connexion with welding and with cryogenics—the science of extreme cold. A big electro-magnet refrigerated to *minus* 452° F. practically loses its electrical resistance and works on a 2,000th of the current needed at room temperature. The use of this possibility of saving in electronic computers is only at its beginning, while other main uses include the maintenance of liquified hydrogen and oxygen in nuclear reactors. Among subsidiary uses are the prevention of rust where machinery is stored in a helium atmosphere, the tracing of leaks in gas systems in atom power reactors, and in connexion with anaesthetics. The output in 1959 should exceed 400,000,000, cu. ft., but demand will already have reached 500,000,000 cu. ft. A new plant is being built in Oklahoma to extend present capacity. To extract helium from natural gas the gas is refrigerated to about 300° F. below zero. Nitrogen is absorbed by coconut charcoal and the helium is shipped in compressed form in tank cars of cylinders. The price of the gas at source is 2 cents per cu. ft., but the cost of transport is another 8 cents. It is hoped to achieve liquifaction, which would considerably reduce this item. [1]

* * *

On the west coast of Sweden fishing is being done by means of a specially designed electric generator, the work of Conrad Kreutzer, a German physicist. Fish such as cod show a tendency to swim towards the positive pole of the electric field and can thus easily be directed to a point where they are numbed by the current so that they float to the surface of the water. A hoop or suction apparatus is all that is needed to catch them. Voltage can be regulated so that the potential drop between the head and tail of the fish corresponds to the size of fish required to be caught and the smaller fish are left to mature. Tuna fishing is a skilled operation usually carried out by anglers; it is proposed that for the electric method a hook be made into the electric conductor. The fish would be numbed sufficiently by a series of d.c. shocks of 4,000 V. to enable it to be towed on board ship and clubbed, considerably reducing the labour involved in conventional tuna angling. [2]

[1] *Agricultural News Letter*, Spring, 1958.
[2] *Science News Letter*, June 14, 1958.

[1] *Economist*, Sept. 20, 1958.
[2] *Comp. Air Mag.*, May, 1958.

At the annual meeting of America's Commercial Chemical Development Association held earlier this year in New York one of the topics discussed was the influence of synthetic rubber and its development for commercial applications on other industries. At the end of the war the polymers used for the manufacture of synthetic rubber could be standardized in respect of average molecular weight, but the chain structure of the material could not be brought under complete control. The time has now arrived when more control of structure will be possible. In the meantime the effects on other industries of an increasing use of synthetic rubber has been marked; 95% of the rubber used for insulation in the wire and cable industry, for instance, is synthetic. Its use has enabled voltages and temperatures (up to 130° C.) to be raised and has resulted in an increase in wire and cable production; lead coating and cotton braiding are virtually obsolete for insulation. In many fields of application, were synthetic rubber not available, specifications would have to be rewritten. This is true of Navy Shipboard Cable Specifications and of the Federal Mine Safety Regulations (schedule 2F). Synthetic rubber provides higher resistance to moisture and future developments are expected to produce elastomers for use at temperatures as high as up to 600° C. with increased high-voltage breakdown resistance and higher moisture resistance. In the tyre industry to-day about two-thirds of the rubber hydrocarbon used is synthetic rubber. All passenger-car tyres in the U.S. market have an all-synthetic tread and a large proportion of the body of the tyre is synthetic too, giving an increase in tread life of 15% to 25% over natural rubber. Although large bus and truck tyres are still making use of a considerable amount of natural rubber even here the picture is changing and when the isotactic polyisoprene polymers are made available commercially it is likely that these may be all synthetic. The function of synthetic rubber in the car industry does not stop at tyres, however. Many critical parts would fail in a year if made of natural rubber and for these synthetic rubber is essential: these include fuel pump lines, diaphragms, valve stem seals, radiator hose, and gaskets. In aircraft design the use of synthetic rubber has parallelled development of improved lubricants. In early days a castor oil was used and natural rubber proved a satisfactory material for seals. Petroleum oils produced neoprene and jet and high-temperature hydraulic fuels have resulted in the production of the nitrile rubbers. In many aircraft applications the high temperatures involved have necessitated the use of fluoronated hydrocarbons. Designs of the future will exact even higher performance. In many other industries synthetic rubber is ousting natural rubber.[1]

[1] *Rubber World*, May, 1958.

Western Australian Minerals in 1957

Minerals other than gold produced in Western Australia in 1957 have been valued at nearly £A7,000,000. To this gold (896,683 fine oz.) worth £A14,000,000 may be added.

Coal (the hydrous bituminous variety from Collie Field) 840,000 tons, valued at £A2,500,000.

Asbestos from the north-west areas of the State: Chrysotile, 1,380 tons, worth £A42,000, and crocidolite (Wittenoom), 11,100 tons, £A1,195,000, a total of approximately £A1,250,000.

Manganese Ores (45% to 49% Mn) from the north-central and northern areas represent an important and growing item (£A930,000) showing that the value and extent of the Western Australian deposits are being recognized to an increasing degree. Haulage alone to railhead or shipping points has become "big business."

Iron Ores occur in vast quantities at a number of points in various parts of the State. At Yampi 63% ore was produced for direct shipment, while at Yilgarn 62·9% ore for local smelting (charcoal-iron) was produced, total value realized £A711,000.

Pyrite for sulphur was available from two sources: (*a*) From Dundas pyrite mine (Norseman Gold Mines, Ltd.) came 45,000 tons (45% S) valued at £A327,700 and from (*b*) East Coolgardie, 12,600 tons (35% S), worth £A55,000. This latter pyrite is closely-cyanided flotation concentrates from Golden Mile sources. The material of both (*a*) and (*b*) is used solely in the manufacture of H_2SO_4. The concentrates from both Dundas and the Golden Mile are railed to coastal plants for the final stages.

Lead.—With the decline in world prices lead production is likely to show a sharp decrease. The Northampton mines have closed or are closing. In 1957 ore worth £A256,000 was produced.

Tin.—From Greenbushes (in the south) ore valued at £A29,700 and from Pilbara (north) ore worth £A125,300.

Copper.—(*a*) Ores and concentrates (16% to 23%) from a wide range of sources, including first production from the recently-rehabilitated Ravensthorpe mines (Phillips River) (560 tons at 16·5%, value £A58,500). (*b*) Agricultural uses with a general average of 10%, value £A82,000.

Ilmenite.—Production £A233,000. This new production of beach-sand concentrate at 54·5% TiO_2 was from south-west coastal areas. Another company is shortly to come into production and the tonnage shipped is likely to step up smartly. The production of other minerals from the same sources—*e.g.* monazite and zircon—is likely.

Silver, a by-product of lead, gold, and copper mining at £A156,000, is an item of considerable importance.

The foregoing are major items, but the following is an interesting range of minerals of growing value.

Beryl.—Production worth £A64,000. Pilbara in the far north is the major producer with 280 tons for £A52,100; Coolgardie (17 miles from "The Old Camp") gave 42 tons for £A7,400.

Talc.—3,500 tons from Three Springs realized £A50,000. A small parcel from Mt. Monger (steatite), where there is a large supply available, realized £A880.

Chromite (42% Cr_2O_3).—Output 1,300 tons for £A21,000.

Clays (excluding brick and tile clays and the like) realized £A34,000.

Gypsum (for plaster).—£A26,000.

Feldspar (microcline) from Coolgardie, fetched £A4,600. The production of excellent feldspar has been a regular industry here for a number of years. Occasionally good masses of beryl and/or columbite have been uncovered.

Tantalite-Columbite.—Production realized £A11,800.

Glass Sand.—From Gnangara (near Perth), a sand with 80% *minus* 80 mesh and nearly free of Fe, £A4,000.

Green Sand (glauconite) worth £A5,040. This supply is from the Cretaceous at Gingin.

Phosphatic Rock (west coast), £A9,000.

Bentonite from Marchagee, 740 tons for £A2,900.

Barite.—£A900.

The figures as given here are taken from Mines Department sources.

News Letters

VANCOUVER

October 8.

Mining Legislation.—The province-wide convention of the Progressive Conservative Party of British Columbia in mid-September was critical of mining legislation enacted by the ruling Social Credit party and unanimously adopted resolutions urging repeal of the Mineral Property Taxation Act and removal of the wide powers conferred by the Mineral Act on the Minister of Mines. The convention was emphatic in its demand for restoration of "security of title and tenure to the owners of mining properties." The convention also endorsed the position of the mining industry in demanding full disclosure of all agreements between the Provincial Government and the Wenner-Gren interests and called for equality of opportunity in "Wenner-Grenland," as the immense territory under survey by Axel Wenner-Gren and his associates is termed locally.

Despite the sympathy suggested by the various resolutions the mining industry was greatly disappointed in the failure of Dr. Desmond F. Kidd, distinguished geological engineer, to wrest the provincial party leadership from the incumbent.

Vancouver Island.—After an operating suspension of three weeks due to forest closure the Empire Development Co., Ltd., resumed the mining and milling of magnetite ore at its Quatsino mine on northern Vancouver Island on August 9. Within a week two shipments had been loaded at Port McNeill for Japanese destination—the *Nichizui Maru* with 16,314 long tons of iron concentrate, the largest B.C. shipment to date, and the *Nichiyo Maru* with 5,642 tons. Production is being maintained under contract by the Mannix Co., Ltd., at 50,000 tons of concentrate monthly, which requires the mining of about 75,000 tons of ore.

Nimpkish Iron Mines, Ltd. has been incorporated in British Columbia as a private company to operate an iron mine at Nimpkish, near the north end of Vancouver Island. The company will be the operating arm of International Iron Mines, Ltd., which in turn is financed largely by the Standard Slage Co., of Youngstown, Ohio. Contracts have been negotiated for the sale to Japanese purchasers of a 62% iron

concentrate at the rate of 350,000 tons annually. Grade of the deposit is estimated at 46% and little difficulty is anticipated in the proposed beneficiation by magnetic separation. Deliveries are to commence during 1959.

Placer Development.—The quarterly report of Placer Development, Ltd., discloses that the subsidiary, Canadian Exploration, Ltd., experienced an operating loss estimated at $169,500 in the three-month period ended July 31, 1958, the first quarter in the current fiscal year. This compares with a profit of $200,000 in the first quarter of the previous year. Both tonnage and grade of lead-zinc ore were higher in the quarter just ended but prices received from the smelter were lower. The company's greatest loss, however, resulted through termination of the premium contract for the sale of tungsten and the consequent closing of the Emerald tungsten mine and mill. Since fulfilment of the contract the company has stockpiled some 36,000 units of WO_3.

During the 1958 quarter production consisted of 10,037 (6,766) tons of concentrates from 104,034 (98,253) tons of ore assaying .2·7% (1·26%) lead and 4·3% (3·53%) zinc and 16,844 (23,056) units of tungsten trioxide from 24,231 (46,652) tons of ore treated containing 0·82% (0·61%) WO_3. Figures in parentheses cover the quarter ended July 31, 1957.

Before the provision of $41,300 ($150,000) for exploration and $130,000 ($150,000) for depreciation and depletion the gross operating profit was estimated at $1,800 ($751,600). No taxes are payable out of operation during the most recent quarter, but in the comparable period of 1957 provision for this purpose required $211,600.

Canadian Exploration and its subsidiaries are particularly active in exploration. Drilling was commenced on the Mattagami Syndicate's property in Northern Quebec and results are reported as encouraging as to both grade and confirmation of indicated reserves. Satisfactory results have also been obtained from preliminary metallurgical investigation. Exploratory drilling on the property of Craigmont Mines, Ltd., near Merritt, has been carried on by Canadian Exploration and in midsummer an underground-development programme was commenced. Farther afield the Canadian Exploration company has acquired petroleum and natural gas permits covering 397,000 acres on Graham, most northerly of the Queen Charlotte Islands, and has entered into an agreement with two operating oil companies for exploration and, if warranted, development of the holdings; each partner to participate on an equal basis.

Canex Aerial Exploration, Ltd., a wholly-owned subsidiary of Canadian Exploration, Ltd., has purchased a petroleum and natural gas Crown-reserve drilling reservation covering 10,240 acres in the foothills of Alberta and a geophysical survey of the holdings is now in progress. Under the terms of an agreement with four oil companies the cost to Canex will be 25% of the total cost of the venture.

The following brief summary describes the operating experience of other subsidiaries of Placer Development, Ltd.:—

The value of oil production of Coronet Oil Co. for the quarter ending July 31, 1958, was $243,678. This compares with $400,290 in the same quarter of 1957.

The American Exploration and Mining Co. continued its investigation of properties in Alaska, Arizona, California, Missouri, Montana, Nevada, Washington, Wyoming, and in the Philippine Islands. Examinations were made of deposits containing gold, silver, copper, iron, uranium, gypsum, boron, coal, and pozzolan. Metallurgical testing has been commenced on a recently-optioned open-pit gold prospect in Montana. Application has been made for Government leases on the most important mining claims, covering a large potential open-pit mining operation on Marinduque Island in the Philippines; exploration has been halted pending acquisition of the leases. Two copper properties in the United States were drilled and later abandoned.

Victoria.—The first shipment of copper concentrate was made by Cowichan Copper Co., Ltd., October 3, when the S.S. *Nichirei Maru* loaded copper concentrate valued at $1,200,000 (net to Cowichan) for Japanese delivery.

Bridge River.—Bridge River United Mines, Ltd., a newly-incorporated company, has acquired all the assets of Bridge River Consolidated Mines, Ltd., one of the earliest and best known of the many Bridge River district operators. It was necessary to re-instate the older company in order to gain title to the properties situated north of the Bralorne mine.

Kamloops.—Torwest Resources, Ltd., has acquired an option to purchase the Pogo group, which completely surrounds the

Hank group of mineral claims on which exploratory drilling is currently being done by Centennial Mines, Ltd., and Magnum Copper, Ltd., jointly. The Hank group is close to and south-west of the main workings of the Craigmont mine, near Merritt. Torwest is currently working on three separate groups of claims in British Columbia (in addition to a group of 50 claims under option to Noranda Mines, Ltd.) and one group in the Mattagami area of Quebec. The company has successfully drilled a gas well in Huron County, Ontario, and has entered into an agreement with a major United States oil company for the drilling of acreage on the Queen Charlotte Islands.

Vanex Minerals, Ltd., has discovered a high-count magnetic anomaly on its 124-claim copper prospect in Meadow Creek area, 14 miles east of the Bethlehem Copper mine. The company is to proceed at once with a diamond-drilling programme, utilizing two heavy drills, as recommended by its consulting engineer. Vanex has also entered into an operating agreement with Dunmore Mines, Ltd., covering development of a group of 50 claims adjoining the Vanex Meadow Creek property. Vanex has paid Dunmore $20,000 cash and granted a 20% interest in all profits in return for the right to earn the remaining 80% interest through production. A magnetometer survey is currently in progress. Vanex Minerals is in a strong financial position as a result of a recent underwriting by New Jersey Loan Co.

Hedley.—During its first full year of production, ended August 31, 1958, French Mines, Ltd., produced gold valued at $243,000 from the French mine at Hedley. The company repaid $65,000 to the parent company—the Cariboo Gold Quartz Mining Co., Ltd.—on capital account.

Greenwood.—Highland-Bell, Ltd., at Beaverdell, earned a net profit of $101,244 in the first half of 1958. Net revenue from the sale of metals was $454,458 and miscellaneous income was $6,905. Total mining and milling expense, including transportation, refining, and marketing, was $217,756. Administration and depreciation were grouped at $35,642 and Provincial mining tax was estimated at $13,165. After provision of $32,127 for income tax and $61,430 for outside exploration the net profit for the six-month period was $101,244, as already stated. The company is participating in exploration through syndicates with other mining companies and so far has enjoyed encouraging results in 1958. The company holds a one-sixth interest in the two million shares of vendor stock of Mattagami Mines, Ltd., a six-million share company performing development work on the promising zinc-copper-gold property prospected and explored by the Mattagami Syndicate. The work is being done by Noranda Mines, Ltd., McIntyre Porcupine Mines, Ltd., and Canadian Exploration, Ltd., and vertical diamond-drill holes on 100-ft. centres have confirmed existence of the indicated deposit estimated to contain 14,000,000 tons of high-grade ore.

TORONTO

October 15.

Gold Production.—The output of the gold mines of Ontario for August included 202,798 oz. of gold and 31,543 oz. of silver, valued at $7,006,517, from 740,459 tons of ore milled.

North-Western Ontario.—A shaft-deepening programme down to 2,970 ft. is to be put in hand by New Dickenson Mines, Ltd., with the object of establishing four new levels. In the first half of the current year the company's output from 78,037 tons of ore milled was valued at $1,443,942.

Steep Rock.—The Caland Ore Company reports substantial progress in preparing its iron ore undertaking for production; initial output is planned for 1960. Efforts are still directed toward the removal of silt material from the lake bed, using two large dredges. By mid-July 113,000,000 cu. yd. of the estimated 160,000,000 cu. yd. of silt had been removed.

The $2,000,000 plant of Canadian Charleson, Ltd., is reported to be functioning well and handling around 450 tons of haematite-bearing gravel per hour on a one-shift basis. Concentrates are being stockpiled.

Blind River.—Milliken Lake Uranium Mines is now reported as working at full capacity. In July 2,844 tons a day was being handled, a figure which rose to 3,240 tons in August. An average recovery of 93·25% has been reported.

Manitouwadge.—The operations of Geco Mines in the first half of the current year resulted in a profit of $1,669,200, the mill handling 319,816 tons of ore in the June quarter, as compared with 316,455 tons in the three months to March 31. At the end of June the drive west on the 850-ft. level

was reported 2,000 ft. west of No. 1 shaft and copper mineralization was reported over widths of from 10 ft. to 19 ft. The company plans a 1,000-ft. winze to continue development work down to the 2,250-ft. horizon.

Saskatchewan.—Exploration at Rix Athabasca Mines is being pressed ahead while consideration is being given to shaft sinking at the Leonard mine. The company reports a profit of $207,000 for the three months to June 30 last, in which period ore shipments averaged 223 tons a day.

The operations of Lake Cinch Mines for the June quarter resulted in a profit of $213,278. Shipments of ore to the Custon Mill in the period totalled 12,633 tons.

Last month it was reported by the International Minerals and Chemical Corporation that the shaft at Esterhazy, about 140 miles north-east of Regina, was half way down to the potash bed at 3,000 ft.

Manitoba.—The Hudson Bay Mining and Smelting Company reports a profit of $1,375,855 for the June quarter. Metal sales for the period realized $7,990,978.

A profit of $825,816 for the three months to June 30 last is reported by Sherritt Gordon Mines. In the period production continued at Lynn Lake, while construction at the Farley shaft also made good progress. Shareholders are informed that demand for ammonium sulphate and anhydrous ammonia was good, while nickel sales were maintained at a reasonable level through long-term sale contracts, in spite of the reduced demand. In anticipation of the expiration of contracts Sherritt Gordon has reached an agreement with the Foote Mineral Co., of Philadelphia, under which the latter will act as exclusive sales agent for its nickel and cobalt in America.

Quebec.—The gold output from Quebec mines for June is reported as 82,811 oz., bringing the total for the first half of the year to 510,828 oz. June shipments of silver amounted to 350,246 oz., the half-year total in this case being 1,970,850 oz. The June asbestos figure is given as 69,508 tons, bringing the output for the first half of the current year to 370,413 tons.

Noranda Mines reports a profit of $4,723,000 for the first half of 1958, earnings having been considerably affected by reduced metal prices. The company's Cutler acid plant in the Blind River area was expected to be completed at the end of September when pyrite roasting was due to start.

MELBOURNE

October 20.

Lead-zinc.—The imposition by the United States of a 20% restriction on imports of lead and zinc is viewed very seriously in Australia. Its fundamental effect will be limiting of the country's annual rate of export of lead to 68,000 short tons, about half the 1957 export of lead to the U.S.A. Broken Hill will be the field most seriously hit, with repercussions in Port Pirie, Risdon, and on expansion programmes; in this connexion the Broken Hill companies had intended to finance large expansion in future years entirely from revenue. Reduced working time is already in force on the mines and it is inevitable that reduction in the labour employed must now follow. The position at the Lake George Mines, for the past two years a marginal mine, is now critical. Employment is 500 men and output 18,000 tons of ore per four-week period, but the town of 2,000 inhabitants is now faced with extinction. It is considered that Mount Isa Mines, Ltd., which sends its lead and zinc output to Great Britain, will not be directly affected, but if other producing countries, restricted by the import cuts, are forced to seek European markets, trading conditions in this area will become much more difficult. It is stated that the Mount Isa expansion programme will not be interrupted. In 1956–57 earnings by Mount Isa Mines from sales of lead and zinc were about £A8,000,000 and these metals represented about half the company's production. The Electrolytic Zinc Co. of Australasia has stated that the company is having no difficulty in selling all the zinc it is producing and will not be seriously affected by the U.S.A. position. It might have to face more serious competition in other export markets, however, if zinc, hitherto sent to the U.S.A., was diverted to other markets and sold in competition with Australian metal. The effect of the restrictions will not only slow down the rate of Australian mining expansion but also the rate of the country's industrial and general development.

An overseas group comprising New Consolidated Gold Fields (Australasia) Pty., Ltd., and two large Canadian mining companies is reported to have become interested in the Broken Hill field and to have taken an option over an area of 2 sq. miles about 5 miles north of the city. The organizations are about to commence investigations into a new

silver-lead-zinc prospect covered by the area under option. The initial geological examination is expected to take a year or more to complete.

Uranium.—A warning has been given that another important Australian dollar earner—uranium—may soon be in danger. It is stated, however, that the entire production of uranium in Australia, known and projected, has been sold forward at favourable prices on contracts which have some years to run. Over production is feared in some quarters, but the long-term contracts should ensure stability. After meeting contract commitments it is considered that there would still be enough uranium in the country to meet Australian future requirements until about 1980.

Reports from United Uranium, N.L., in the Northern Territory, advise that recent drilling in the Scinto 5 ore-body has indicated 5,500 tons of ore containing 49,000 lb. of uranium oxide. Further ore has been met in the Palette ore-body and high-grade ore has been cut in an exploratory adit. In the El Sharana open-cut 5,082 tons of ore assaying 10·66 lb. uranium oxide per ton have been broken ready for transport to the stockpile at the Northern Hercules treatment plant. The Commonwealth Government has allocated £A300,000 for the construction of a mining purposes road from Pine Creek to the South Alligator uranium field.

Mount Lyell.—The year 1957–58 was one of higher tonnage and grade of ore for the Mount Lyell Mining and Railway Co. and resulted in a profit instead of a loss as in the previous year, despite a fall of £A38 per ton in the average price received for copper. The overall profit was £A365,142, which included £A9,000 from higher investment income. The year was the first full test of the new plant which has expanded the output of ore to 2,000,000 tons and the copper production to 10,000 tons per year. In the period the company treated 2,006,788 tons of ore for the production of 47,155 tons of concentrates containing 10,420 tons of recoverable copper. In the previous year 1,706,350 tons of ore were treated for 35,670 tons of concentrates containing 7,741 tons of recoverable copper. The assay value of the ore treated in 1957–58 was 0·652% copper, as compared with the previous year's assay figure of 0·580%. At West Lyell ore reserves are estimated at 41,319,000 tons with an average value of 0·74% copper and 0·067 oz. of silver and 0·008 oz. of gold per ton. Drilling has indicated at least 50,000,000 tons of ore averaging about 1·0% copper below the proposed floor of the West Lyell open-cut and drilling to greater depth is proceeding. Whether this ore can be mined profitably by underground methods is to be investigated. In the North Lyell Corridor area there is an ore-body containing some 5,000,000 tons of 1·0% copper ore and another ore-body containing ore averaging 5·0% copper.

Peko Mines.—Peko Mines is the Northern Territory's rich copper producer. In the last financial year the company's Australian market was limited by local smelting and refining capacity and low Australian demand. The low world price did not permit negotiation of export contracts. In the period, despite difficulties, the company made a profit of £A130,814, against £A87,883 in the previous year. The total copper produced was 7,486 tons as compared with 5,323 tons a year ago. Of the output for the year 1,579 tons were exported, against the previous 3,322 tons. In the financial year 3,984 tons were sold in Australia and the company has negotiated for the treatment and sale of 6,000 tons in Australia during the current year. Ore reserves are estimated at 1,017,300 tons, which include 625,800 tons of proved ore with an estimated grade of 8·1% copper. The directors state that the fixing of the Australian price for copper at £A285 per ton in May, 1958, with a subsequent increase to £A290 per ton in August, would be unprofitable to the company, assuming costs to remain steady. To meet this position the Commonwealth Government introduced bounty legislation and Peko is eligible for bounty to a maximum of £A45 per ton on copper sold in Australia, or such total bounty as will give a return of 10% before taxation on the assessed capital employed in the production of copper, which is currently estimated at £A1,600,000.

Investigations have been in progress into smelting and Fluo-Solids treatment of the ore which indicated a probable saving of 20% of combined transport and realization charges—£A1,293,632 in 1957–58—at a capital cost of £A1,000,000. No immediate plans are proposed for such a plant because of the limited tonnage of current ore reserves. Development will be pressed during the current year, with some reduction in grade to the mill resulting from the lower-grade development ore.

Brown Coal.—The question of producing petrol from the brown coal of Yallourn and

Morwell, Victoria, is again attracting attention. A recent statement put the possibilities of such production at 80,000,000 gal. per year or 40% of Australia's needs. The Joint Coal Board has reported that motor spirit could not be produced from coal at a price which would compete with spirit from crude oil. Development of such an enterprise is considered to be a matter for the Victorian State Government and the Electricity Commission rather than of the Commonwealth Government.

Tasmanian Mineral Output.—The Tasmanian mineral output fell by nearly £A2,000,000 in 1957, as compared with 1956, respective values being £A12,588,719 and £A14,364,337. The fall in value has been due to the decline in the market price for lead, zinc, copper, tin, silver, and tungsten. The average number of men employed in the mining industry increased from 7,692 to 8,137, due to the employment of more labour at metallurgical works. Employment in coal mining, however, decreased, as also the number of men employed in tin and tungsten mining.

The Mines Department has opened tracks for access by field parties to the iron deposits on the Savage River, where the existence of large magnetite deposits had been disclosed by the first Government bore. The future of this deposit depends on the quantity and grade of ore, to be determined by boring, and the suitability of the ore for the steel industry. Two bores should provide this information, but much more drilling will be necessary to establish reserves sufficient for commercial operations on the deposit.

Central Norseman.—Diamond drilling at the Central Norseman Gold Corporation, Western Australia, has given good results on the Crown Reef in the Regent Shaft area. Underground drilling from the end of the south drive on No. 16 level at a depressed angle of 40° intersected a reef between 97 ft. 6 in. and 107 ft. 4 in. assaying 15·2 dwt. over 118 in. A second bore drilled north-west horizontally intersected a quartz reef from 46 ft. 3 in. to 51 ft. 6 in. assaying 60·4 dwt. over 63 in.

Aluminium.—A report by the Australian Aluminium Production Commission, to the Minister for National Development stated that Australia could not reduce aluminium production costs on present production capacity to compete with Canadian prices. The Bell Bay plant is only one-third of the capacity of the smallest plant in North America. The Commission stated that the production rate of the Bell Bay, Tasmania, plant was 11,000 tons per year and that Australian demands for new aluminium in the current financial year were estimated at 25,000 tons. The Commission's net profit—£A25,792—was less than one-half the £A52,359 earned in 1956–57. This is attributed to technical difficulties, lower selling prices, and the problems associated with commencing production on new types of aluminium products. There were failures in the life of the furnaces and lack of previous experience in furnace construction caused difficulty in rebuilding. Since June 30 more furnaces were operating than at any time in the past and maintenance rates were falling. There has also been a lower labour turnover reflecting beneficially on all aspects of the work.

Expenditure by the Commonwealth Aluminium Corporation on work associated with the Cape York bauxite deposits at Weipa is expected to exceed £A1,000,000 by the end of 1958. Expenditure has already been more that £A750,000. In addition, the Zinc Corporation, Ltd., an associated company, has spent £A180,000 sinking a deep prospecting well at Weipa in search of petroleum or natural gas and artesian water. The company has in hand an extensive programme to establish the total tonnage in the Blair Athol coal deposits and to determine whether they could become the source of power for the treatment of the Cape York bauxite. Drilling alone is expected to cost about £A50,000. In the search for cheap power the corporation took options over known coal deposits at Blair Athol. The corporation's associate British Aluminium Co., Ltd., is investigating hydro-electric resources in New Guinea.

Oil.—West Australian Petroleum Pty., Ltd., has approved plans for operations during 1959 and 1960 and the necessary finance has been arranged. An extensive programme of seismographic field surveying will be carried out in the Kimberley country during the next few months. Showings of oil in the Meda No. 1 well and the Goldwyer No. 1 well are sufficiently encouraging to prompt a decision to carry out additional work in the locality, but too much significance should not be attached to the showings. The two wells are about 200 miles apart and situated in entirely different structural regions.

A Bill has been introduced into the

Queensland Parliament having the object of attracting overseas money into the search for oil in the State. It will ease the limitations on the number of permits or leases that could be held by companies. The State will be divided into three prospecting divisions. If a company held five or more permits or leases in one division it would not be permitted to hold more than five in any other division. It appeared that there is insufficient money in Australia for prospecting for oil on a large scale and greater incentive is considered necessary to attract overseas money into the search here.

Great Western Consolidated.—The history of this Western Australian gold-mining company has been disappointing. Exploration and development have been carried on actively, but the grade of ore developed has continued to be low. A late report states that diamond drilling and cross-cutting at the quarry on the Copperhead mine have indicated that the ore extends beyond the reserves. Fraser's mine, at Southern Cross, has given good values in development work, but the tonnage disclosed appears to be rather disappointing. The company took up the Nevoria mine, in the Marvel Loch district, but initial results did not seem to reach expectations. However, a recent report advises that prospects are brighter than a year ago. A recent move by the company has been the taking of options over the Great Victoria mine, at Burbidge, south of Marvel Loch, and it has also pegged a number of surrounding leases. The laterite deposits at Burbidge were worked extensively in pre-war years.

FEDERATION OF MALAYA

October 15.

Prospecting.—Malaya should soon be able to resume her tin prospecting now that the end of the 10-year fight against the Communist terrorists in the jungle is in sight. Mr. Chong Khoon Lin, president of the All-Malaya Chinese Mining Association said at the annual meeting, for instance, that before long the country might return to " a peacetime economy." The emergency situation in Malaya had improved a great deal since the last meeting. Referring to the International Tin Agreement he said the association had appealed to the Government for a suspension or relaxation of the contributions tin miners are required to make to the Buffer Stock. Mr. Chong was a member of a delegation of Federation miners which called on the Prime Minister, Tengku Abdul Rahman, in Kuala Lumpur recently and urged him to speed up the alienation of land for mining purposes. The Premier assured the delegation he would look into the matter.

Mr. Chong's view is that if Malaya is to maintain its position as the foremost tin-producing country in the world she must catch up with the years lost in prospecting.

Iron.—Mr. Ng Hong Heng, a director of the Perak Iron Mining Co., Ltd., of Kuala Lumpur, recently stated that the company has temporarily shelved a proposed pig-iron project. The mill was planned to be set up at Damar Laut next year. Priority is being given to mining operations.

Pakistan.—The Pakistan Government has decided to grant special concessions to undertakings engaged in the exploration and extraction of minerals in the country. In future, it has been announced, all expenditure on prospecting and exploration up to the stage of commercial production will be computed and treated as a loss to be set off against the income of the undertaking after it starts commercial production. The whole of this loss will be allowed in the first year of production if the income exceeds this amount; otherwise the loss can be carried forward until it is fully absorbed up to a period of 10 years. In addition all capital expenditure on machinery and equipment required for extracting the ore will be allowed as a revenue expenditure. If this expenditure cannot be set off against income from commercial production in the first year it will be carried forward and set off against income in later years until it is completely set off.

To encourage the setting up of refining plants a tax concession will be allowed. According to this profits up to 5% of the capital employed in the refining organization will be exempt from tax for a period of five years. This concession will apply only to those concerns which, apart from extracting the ore, refine or " concentrate " it also in Pakistan. These concessions will apply to undertakings engaged in the prospecting or extraction of such minerals only as are essential to Pakistan's national requirements.

Oil Discovery in India.—Mr. K. D. Malaviya, India's Minister for Mines and Oil, has announced in New Delhi that engineers have struck oil at Cambay, about 150 miles north

of Bombay, but three to 12 months of intensified drilling will be needed to find out if it is a commercially exploitable field. Drilling operations were started with a Russian Uralmash-3D turbo drill and a depth of 5,368 ft. was reached before drilling was stopped so that data could be taken. Next day when the drilling mud was circulated thin films of dark brown oil were seen to come to the surface with the return mud. When the casing was lowered a few days later and mud circulation resumed oil started to re-appear and flowed with the mud in a continuous stream for about 15 min. The weight of drilling mud at the bottom of the hole suggested that the oil was under considerable pressure.

Indian Exports.—The Indian Government has decided that mercury oxide and mercury sulphide should be licensed freely for export to all permissible destinations except the Portuguese possessions in India. It has also been decided that vanadium ores and concentrates (excepting vanadium-bearing iron ores) and tungsten ores and concentrates should be licensed for export on an *ad hoc* basis.

Ceylon.—Ceylon's Governor-General, Sir Oliver Goonetilleke, said recently in Colombo that the Government had continued to lay emphasis on industrialization as a vital aspect of the country's general economic development. Increased attention had been paid to industrial development in the public enterprise sector and work had already started on the manufacture of salt and by-products and the refining of ilmenite. Plans included the setting up of a cement works and a steel rolling mill. Work was proceeding on further surveys of the island's mineral resources.

Borneo.—Two Japanese salvage experts, representing a Hong Kong firm, have been carrying out investigations in Borneo for the Shell organization which may lead to marine oil drilling platforms being sold for scrap. Drilling operations from both platforms have failed to find oil.

Marine drilling around the British Borneo coast has stopped temporarily, pending the arrival from Britain of a mobile drilling barge which will be able to operate much more cheaply than the semi-permanent platforms secured to the sea bed.

Dr. G. E. Wilford, Government Geologist, has announced the discovery of " important and large deposits of first-class sands " at the mouth of the Tutong River, in Brunei. It is expected that they will prove worthy of exploitation.

JOHANNESBURG

October 30.

Gold–Uranium.—While there has been no reclassification of gold–uranium mines for taxation under the lower rate of the normal company tax instead of the higher gold tax formula, the Income Tax Act of 1958 appears to provide for the former in so far as any income derived from uranium and pyrites is not so derived in the course of mining for gold. However, the matter seems to be in the discretion of the Commissioner for Inland Revenue. Nevertheless, there appears to be need for clarification. A disadvantage of the normal company tax is that the amortization of capital expenditure is such as to make the company liable for tax sooner than under the gold tax formula provisions.

The quotas for uranium oxide production for the final 1958 quarter indicate that declines in output will be in the majority in that period. The only possible increases under the quotas could be recorded by Ellaton, Afrikander Lease, and, because of its separate contract with the British authorities, Harmony (and the combined project embracing Presidents Brand and Steyn, Welkom, Loraine, and Freddies Cons.). There should be no significant changes in respect of Buffelsfontein and Stilfontein.

Electricity Supply.—It would appear that the Act No. 40 of 1958, which consolidates the laws relating to the control of the supply of electricity and other incidental matters, has extended the scope of the Electricity Supply Commission. The Minister of Economic Affairs may direct the Commission to investigate whether it would be desirable for it to supply electricity within any area. On the basis of the resulting report and after consulting the Electricity Control Board, the Minister may decide that the Commission should supply such an area and would through the Board grant the required licence to supply. Under certain conditions and after five years from the start of supplying two-thirds or more of the consumers in any area have the right to ask for a transfer of the Undertaking to another operator than the Commission and the Minister has the power to refer the matter to the Governor-General for decision. Tariffs charged by the Commission shall cover the overall cost of production, interest on loans and loan redemption charges, and annual appropriations for approved reserves, subject to variations by

the Minister. The Electricity Control Board functions independently of the Commission and other Undertakings. The Act provides for flexibility in supplying power where such would be required and for local authorities to supply outside their areas of jurisdiction. The Act repeals wholly or in part 14 previous enactments.

Transvaal. — The intensive mechanical sorting and beneficiation of run-of-mine ore at Doornfontein Gold Mining again improved the yield to 8·298 dwt. a ton in 1957–58 from 8·057 dwt. and to 0·251 lb. U_3O_8 from 0·234 lb. The ore reserves were raised to 2,507,000 tons, averaging 7·4 dwt. gold and 0·19 lb. U_3O_8 per ton from 1,956,000 tons averaging 7·4 dwt. and 0·21 lb. Preliminary work for the sinking of the sub-vertical shaft in the south-eastern section of the mine has been well advanced and the sub-shaft area has been connected with the workings in the No. 1 Shaft area to the north-east by a single cross-cut on one level, which provides access to the engine chamber and serves the ventilation arrangements, and by a twin-haulage on a slightly deeper level, which also serves for ventilation purposes. Sinking proper should be got under way in the near future.

Apex Mines, which operates the Greenside colliery, has decided that to help counteract fluctuating supplies of native labour especially in underground operations the No. 4 Seam should be opened on the basis of extensive mechanization for an output rate of 30,000 tons to 35,000 tons a month. To help finance the scheme 300,000 reserve shares will be issued at par, 10s. each, to shareholders.

West Driefontein Gold Mining, which, like Doornfontein, is also applying intensive mechanized sorting and beneficiation to its run-of-mine ore, discarded waste from ore to the extent of 31·1% in 1957–58 (as compared with 30·8% at Doornfontein). The yields were consequently increased to 19·19 dwt. gold and 0·285 lb. U_3O_8 from the 1956–57 levels of 18·843 dwt. and 0·264 lb. Ore reserves were increased to 2,546,000 tons averaging 16·8 dwt. and 0·23 lb. from 2,080,000 tons averaging 16·8 dwt. and 0·23 lb. The vertical component of the No. 5 Shaft in the south-western section has been completed to a final depth of 5,650 ft., while the sub-vertical component being sunk from about 4,900 ft. below surface will be sunk to about 8,000 ft. The vertical component, which is situated in the vicinity of the Ventersdorp Contact Reef sub-outcrop, has not been reported as passing through this horizon and may therefore be a little north of the strike. The completed No. 3 Shaft in the north-central section was recently commissioned on a small scale for hoisting, but no stoping operations have yet been reported in the shaft area. The same mining layout is being followed as more to the west—namely, cross-cutting in country-rock from shaft level stations at about 200 ft. vertical intervals, then advancing foot-wall drives along strike and cross-cutting to reef at strike-intervals of about 800 ft., followed by rising to form the stope-blocks and by cutting reef drives. The stope faces are cleaned by scraping.

Blyvooruitzicht Gold Mining is considering sinking a third shaft, a circular unit, which would probably be situated in the south-eastern section. A twin main haulage has already been driven on 6 Level from the workings in the north-eastern section to what is probably the underground projection of the shaft site. It is assumed that in due course a sub-vertical component of the shaft being considered would also be sunk, first to open up the deep section and secondly to provide a starting point for driving into Western Deep Levels, contiguous with the southern boundary of Blyvoor. and West Driefontein. (A similar plan doubtless has been formulated in respect of the West Driefontein No. 5 Shaft.)

It has been unofficially reported that four drills are being operated in the Potchefstroom area in a programme of gold exploration. One is sited east or north-east of the town and the other three to the south. It is also understood that the main bed of iron ore of the Pretoria Series to the north of the town is receiving attention. This bed, from 2 ft. to 8 ft. thick approximately, runs at 45–50% Fe.

In sinking the Far East sub-vertical shaft of East Rand Proprietary badly-broken water-bearing ground has been encountered. Cementation is proceeding. Operations have been delayed.

Orange Free State.—Harmony Gold Mining, which has been milling about 92,300 tons a month, has commissioned the third unit of its gold plant. Each unit has a rated capacity of 50,000 tons a month. Installation of the fourth unit has been started and should be completed by about the beginning of 1960. The addition of a third unit to the uranium plant, which will increase the rated capacity by 40,000 tons a month to 120,000 tons, is nearing completion or has been completed. A third

unit of 40,000 tons a month capacity is now being added to the pyrite plant and, expected to be completed by about the second 1959 quarter, will raise the overall capacity to 120,000 tons a month. A sulphuric acid plant with a rated acid output capacity of 120 tons a day is being erected and should be completed after mid-1959. The No. 2 shaft, a little more than 5,000 ft. to the north of No. 3, connected with the latter workings by a twin-main haulage and recently completed to a final depth of 5,535 ft., has been commissioned for hoisting. Stope formation in the No. 2 Shaft area has been in progress some time, but stoping is not yet under way. The latter should be initiated in the near future in a zone which in 1957–58 added ore to the mine payable reserve 3 dwt. higher than in the lower-grade south-eastern section where the average was 8·5 dwt. a ton. The extension of underground development and stoping, especially in the central No. 2 Shaft area, may enable the mine to build up the mill grade to a level more representative of the mine as a whole, which drilling indicated would be of the order of 12 dwt. to 14 dwt. a ton against the present yield of about 8 dwt.

In addition to its other various mineral and participation rights, the latter of which includes the Western Areas Prospect or Waterpan Block under the control of Johannesburg Consolidated Investment Co., Ltd., Free State Development and Investment Corporation, Ltd., owns the mineral rights of the Farm Bandon 345. This is surrounded on all sides—on the west and south by the Riebeeck mine ; on the north by Loraine ; on the north-east by Jeannette, and on the east by Freddies Consolidated. The rights extend over 655·2 claims, all of which are stated by the chairman to be underlain by Basal Reef. He could not say at this stage what the value is. The rights did, however, have a potential value in the future.

The eastern section of President Brand Gold Mining is disturbed by a major fault system, which on the western side throws the reef bodies down and on the eastern side throws them up to the extent of some thousands of feet. Drilling, which has previously been concentrated relatively more to other sections, has now yielded further geological information about the eastern section on the downcast side of the fault. A bore-hole drilled about 2,650 ft. east of No. 2 Shaft adjacent to the fault has intersected the Basal Reef at 7,242 ft. below surface. An incomplete exposure in the first intersection yielded values of 1·078 in.-dwt. and 14·652 in.-lb. of U_3O_8 ; a deflection gave complete exposure with values of 3,376 in.-dwt. and 40·443 in.-lb. The section had not been assessed as relatively high-grade. A re-assessment is now necessary, subject to further disclosures in due course.

Cape Province.—In the district of Jamestown, a rail-head about 50 miles north of Queenstown in the Eastern Cape, a discovery of gold was recently reported. Details are not yet available, but it would seem likely that the metal would be associated with an igneous intrusion into Karroo sediments or derived from such an intrusion. The zone is about 150 miles west of the complex Insiwza deposits near Mount Ayliffe. The latter are also associated with a massive and extensive igneous intrusion in Karroo sediments.

Trade Notes

Brief descriptions of developments of interest to the mining engineer

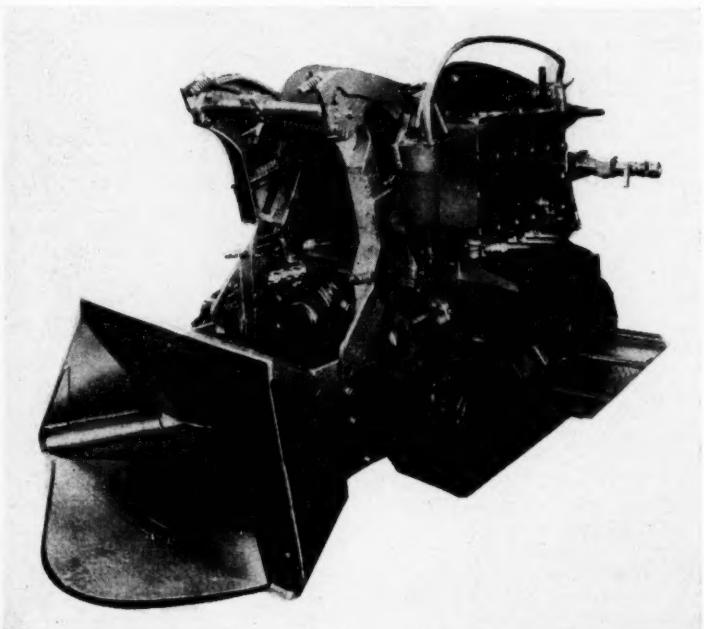
Heavy-Duty Shovel Loader

Particulars have recently been released of a new addition to their range of loading machines by **Eimco (Great Britain), Ltd.,** of Team Valley Trading Estate, Gateshead-on-Tyne. This is the Model 622 RockerShovel and it is illustrated here. As will be seen it is crawler mounted and is available with either compressed-air or flameproof-electric

drive. For air operation two 5-cylinder radial air motors each developing 12 b.h.p. provide traction, one driving each track. A third identical motor operates the bucket and rocker arm assembly. Equipped for electrical operation the loader can be supplied for 380 volts to 660 volts a.c. with flameproof Buxton Certificated motors and control gear suitable for Class I and Class II atmospheres. The simple overhead rocker arm action gives five to six full bucketloads a minute each of ½ cu. yd. capacity. The bucket covers the full width of the tracks and, by a simple adjustment, four separate digging positions are provided varying from above track level to 4 in. below. The independently-driven and controlled tracks give good manœuvrability, permitting the machine to turn virtually within its own length. Electric versions are fitted with a hand-controlled track brake which enables the operator to spot the machine with ease and accuracy when coming up to discharge the bucket. On both models the overall width is 5 ft. 9½ in., the headroom requirement varying from 8 ft. 10 in. to 9 ft. 1 in. and the discharge height from 5 ft. 2½ in. to 5 ft. 11½ in. Alternative discharge heights are available to meet special requirements. Travelling speed is 2¼ m.p.h. Air consumption ranges according to load from 350 c.f.m. to 400 c.f.m. with pressures from 60 p.s.i. to 120 p.s.i.

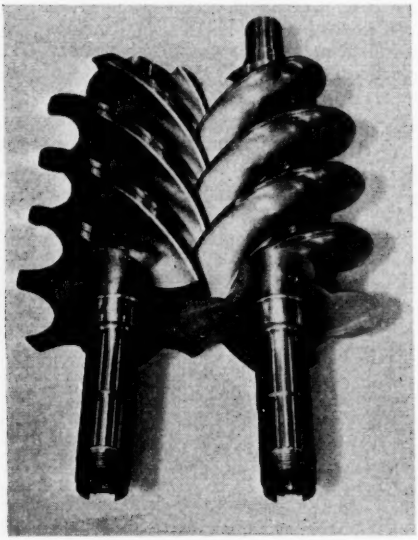
Rotary Screw Compressor

A portable rotary screw compressor which has been developed with built-in pressure ratio and axial-flow characteristics is announced by **Holman Bros., Ltd.,** of Camborne, Cornwall, following agreement with **James Howden and Co., Ltd.,** of 195, Scotland Street, Glasgow. Known as the Rotair it is a compact lightweight machine delivering air free from pulsation. The compressor consists essentially of two helical fluted intermeshing rotors mounted in one casing as shown in the illustration. As they rotate air is drawn through the inlet port to fill the interlobe space. The air is then trapped and compressed with a progressive reduction in the volume space until released into the discharge port of the compressor. The male rotor, which has four lobes, absorbs practically all the power required by the compressor. The



Eimco 622
Electric Powered
Rockershovel

female rotor, which has six lobes, functions as a rotary valve resulting in a continuous piston effect. High efficiency is achieved in a single stage by the use of oil cooling which

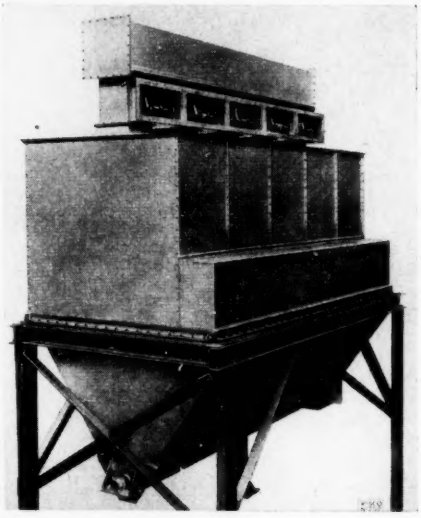


results, without the aid of inter and after coolers, in air-delivered temperatures at least 100° F. less than those obtained by other methods.

Automatic Dust Collector

A recent addition to the dry dust collecting equipment offered by the **Visco Engineering Co., Ltd.,** of Stafford Road, Croydon, is the Bermax collector illustrated here. This is especially suitable for high-temperature conditions and for recovery of dusts of no commercial value. It comprises a heavy-gauge sheet-steel casing, hopper, and common inlet expansion chamber constructed in flanged panel formation, the casing and hopper being divided into compartments according to capacity. Each compartment houses a spring-mounted filter bed consisting of a primary cell filled with steel shavings and a secondary cell filled with stone chippings graded according to the dust loading and particle size of the material handled. Each filter bed is connected directly to a shaker motor which is mounted externally on one side of each compartment of the collector casing. The hopper is fitted with a spiral conveyor driven by a geared motor and a rotary air lock dust discharge valve.

An isolating damper to each compartment is fitted in the taper outlet on top of the collector, all the compartments being connected to the common cleaned air/gas exhaust header. Each damper is operated by a compressed-air cylinder controlled by a solenoid valve from an automatic control panel. On the commencement of the cleaning cycle this energizes the solenoid of No. 1 compartment which closes the isolating



damper. After this has been closed for a few seconds the shaker motor is brought into operation and vibrates the filter bed for some minutes. The motor then stops and after a delay of a few seconds the isolating damper opens and the compartment is brought back into service. There is a further delay of several minutes and the cleaning cycle is then repeated on No. 2 compartment and so on throughout the collector.

The frequency of the cleaning cycle may be varied according to different known conditions in each case or as may be found necessary from experience.

The standard collector is designed for gases up to a maximum temperature of 120° C., but by the provision of certain special parts gases with temperatures up to 400° C. can be dealt with. As already stated, the secondary filter medium is graded in size according to the type of dust being handled ; in addition, the depth of the medium is also varied.

Screw Compressors at Kiruna

In an article in the September issue describing a " Screw Compressor Installation at Kiruna " it was stated the two machines were manufactured by Svenska Rotormaskiner A.B. In fact, however, **Atlas Copco A.B.** have secured from Svenska Rotormaskiner the rights to produce compressors of their own design incorporating the Lysholm principle. We regret that our note was in this respect misleading.

Personal

G. KEITH ALLEN has been appointed to the board of Mining Services (P.E.), Ltd., a member of P.E. Management Group, Ltd.

B. BARTLETT has left for Ghana.

A. P. A. BOISSIER is now in Canada.

R. T. BRANDT has left for Northern Rhodesia.

E. J. D. BROWN is home from Sierra Leone.

G. F. A. BURGESS has been appointed a director of the Esperanza Copper and Sulphur Co., Ltd.

G. A. DANIELS is now in Australia.

K. DENHAM has been appointed superintendent in charge of the operations of Great Western Consolidated, N.L.

R. H. L. EGERTON is returning from Canada.

F. F. ESPIE has resigned from the post of deputy managing director after 15 years in charge of operations of Western Mining Corporation, Ltd., and associated group companies in Western Australia. He has been appointed vice-chairman of the Corporation. L. C. BRODIE-HALL, who has for the last seven years been superintendent of Great Western Consolidated, has been appointed general superintendent in charge of Western Australian operations to succeed Mr. Espie.

M. FORSTER is now in South Africa.

A. P. GAGNEBIN has been appointed a vice-president of the International Nickel Co., Inc.

W. GIBSON is now in Sierra Leone.

ANTON GRAY is visiting South Africa.

A. T. HOLMAN, chairman and joint-managing director of Holman Bros., Ltd., has relinquished his office of joint-managing director but he will be remaining on the board and will continue to act as chairman.

J. F. HOLMAN has been appointed a joint-managing director of Holman Bros., Ltd.

E. H. JAQUES has left for Ghana.

J. DE KLERK is the new South African Minister of Labour and Mines.

L. R. MABSON is now in Northern Rhodesia.

D. M. MACPHERSON is now in Northern Rhodesia.

HARRY F. MCFARLAND, consulting mining engineer, of Denver, Colorado, is now on assignment for the International Labour Office (United Nations), in Rangoon, Burma. He is advising the Burma Government and teaching mine engineering in the newly-formed Mining Department of the Government Technical Institute.

ROBERT C. MEADERS has been appointed assistant manager of the Mining, Crushing, and Process Machinery Division of the Nordberg Manufacturing Company, Milwaukee, Wisconsin.

GEOFFREY H. PERKS is now in India.

F. S. POLLARD, H.M. Senior District Inspector of Mines and Quarries in the Scottish Division, has been appointed H.M. Divisional Inspector of Mines and Quarries in charge of the West Midland and Southern Division, in succession to J. E. HENSHAW who has retired.

G. E. SAVORY (sales director) and D. H. MARLOW (export sales manager) of Ruston-Bucyrus, Ltd., left at the end of September for a visit to the United States, New Zealand, Australia, and Singapore, returning at the end of November.

G. A. SCHNELLMANN left London in October to pay professional visits to Iran and India and will be returning towards the end of the year.

D. SIMMONS, of Mackay and Schnellmann's Teheran office, is paying a short professional visit to India.

C. E. THWAITES has left for Malaya.

J. M. WELDON has been appointed an assistant vice-president of the International Nickel Co., Inc.

PETER WESTERBERG has left on a visit to Kenya.

W. G. YUILL, of Mackay and Schnellmann, left London in late September for Iran.

F. A. SPENCE-BROWN, a joint-managing director of Johnson, Matthey, and Co., Ltd., died suddenly on September 29.

Sir DIGBY VERE BURNETT, who died on November 3, aged 83, was a pioneer in South Africa, where he arrived in 1892. Early in the present century he became associated with Sir Edmund Davis, for whom he worked first in West Africa and, later, in Rhodesia. Since 1920 Sir Digby had been prominently identified with mining affairs in the Rhodesias, where he was a director of many companies. A Member of the Institution of Mining and Metallurgy, Sir Digby was also a Member of the Rhodesian Iron and Steel Commission.

INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Member.—Gotthard BJÖRLING, M.Sc. (*Stockholm*); Sydney CHRISTIE (*Melbourne*); Felix A. SCHAUFELBERGER, M.Sc., Ph.D. (*Basle*).

Associate Member to Member.—Ian Fergusson CAIRNS, B.Sc., A.R.T.C. (*Johannesburg*); Daniel Glyndwr DAVIES, B.Sc. (*Johannesburg*); Charles Darrell HALLAM, A.R.S.M., B.Sc. (*Oranjemund*); Bernard William Hugh HARDING, A.R.S.M. (*Nairobi*); James Benjamin HOOPER, A.C.S.M. (*St. Agnes*); Jack Kinnear MACDONALD (*Selukwe*); John Henry SCHLOEN, B.E. (*Montreal*); John Tillard Meadows TAYLOR (*Oorgaum*); Lewis O'Neill THOMSON, A.O.S.M. (*Stroud*); Alfred Sydney VINCE (*Ottawa*); John Stuart WEBB (*London*); John Richard WRIGHT (*Johannesburg*).

Associate Member.—John Wetheral GRAHAM, B.Sc. (*P.O. Penge, Transvaal*); Geoffrey Simon HANNES (*Kalalushi*); Gurbachan Singh MARWAHA (*Dhanbad*); William Ernest RAY (*Kalalushi*).

Student to Associate Member.—Caryl Beddy

BRISTOWE, B.Sc. (*Mufulira*); Christoffel Frederick BRUGMAN, B.Sc. (*Potchefstroom*); James Peter DAVIES (*Vananda, B.C.*); Brian Lewis FENOULHET (*Beckenham*); John Reginald Storr HELLIWELL, A.C.S.M. (*Atikokan, Ont.*); Wilfred Daniel JONES (*Segbwema*); Peter Frederick MEAL, B.Sc. (*Entebbe*); Keith John MENADUE, A.C.S.M. (*St. Austell*); James Duncan MURDOCH, A.C.S.M. (*Carlsbad, N. Mexico*); Gordon Anderson TAIT, A.R.S.M., B.Sc. (*Jos*); Kenneth Andrew Lowrie Graham WATT (*Dunfermline*).

Affiliate.—Kalathur Rajagopalan RANGANATHAN, B.Sc. (*Marikuppam*).

Student.—Santosh Kumar GHOSH (*Leeds*); Henry Graham KING (*London*); John Michael SAMMONS (*Dawlish*); John Harold Gilham TANKARD, M.A. (*Edmonton, Alberta*).

Metal Markets

During October [1]

Copper.—The background to the copper market [2] in October has, quite simply, been made up of continued strikes in both Rhodesia and Canada and the growing nervousness about the level of future supplies which these strikes are bound to bring. In particular, the U.K. market is perturbed by the duration of the stoppage in Rhodesia, which is such an important supplier to this market and the generally rising trend of prices, coupled with the widening backwardation, are eloquent testimony to this anxiety. It is true that, as soon as the Rhodesian strikes are over, the producers can resume output very nearly at capacity instead of at the reduced rate in force when the strike broke out. It is also true that other producers in various parts of the world have a greater production potential than they are at present employing, although it should be noted that during October two of the big American producers restored output cuts affecting their U.S. mines which they had made earlier. Nevertheless there is at present no source of supply which looks capable of meeting the anticipated shortfall in arrivals with spot metal.

For most of October, in proportion as the prospects of a spot metal supply stringency grew more serious, attention was increasingly focused on the 27,000 tons of metal which the U.K. Government deferred selling from its stockpile holdings at the end of last year. However, on November 3, it was learned that the Government would release 10,000 tons in the two and a half months from mid-November, a barely noticeable quantity in the context of U.K. requirements. As this report is written, the prospects for a return to work on the Copperbelt seem rather better than of late. Also, Dr. John F. Thompson, chairman of the International Nickel Co., said in London recently that he did not believe that the strike in Canada (which as we have explained previously is primarily a nickel strike) would go on for any great length of time, as the issue was purely one of money and not one in which any major principles were involved. Nevertheless, these two strikes continued throughout October, against all probability and, at the time of writing, it is difficult to see any new reason for their conclusion except that they are, of course, a month older.

[1] Recent prices, pp. 264, 304.
[2] See Table, p. 304.

Copper consumption in the U.K. in the holiday month of August was 42,181 tons, of which 33,073 tons was refined copper. Production comprised 3,081 tons primary refined and 4,775 tons secondary refined, while stocks of blister copper dipped to 23,473 tons and of refined copper rose to 66,426 tons.

Tin.—After September's debacle and subsequent astonishing recovery in the tin market October would probably seem quiet by comparison anyway. As it happens, the market [1] has been more than usually quiet, largely marking time until the outcome of the next meeting of the International Tin Council is known. Among other things, this meeting will have the significant duty of establishing the export quotas for the first quarter of next year for the producing countries adhering to the Agreement. On the whole it is hoped that the evidence of the success of the Tin Agreement so far will encourage the producing nations to agree to further export restriction, despite the obvious temptation to press for relaxation now that prices are better than they were when the Buffer Stock was operating on the market. It should not, however, be forgotten that part of the strength of the London market since September has been due to the marked decline in the volume of offerings of Russian metal—to the point where they have virtually ceased. In the U.K., of course, the import quota helps to keep the level down, but offerings on the Continent, too, seem to be less aggressive. How far this may be due to representations that Russia, by dumping tin in Western markets, is not adhering to her professed intention of aiding underdeveloped countries, is hard to say.

U.K. August consumption was 1,412 tons and production 2,423 tons. Stocks eased to 19,676 tons.

Lead.—Contrary to what might have been expected one of the first effects of the U.S. import quotas on lead has been to help keep London prices [1] fully steady, if not firm, during October. This has been due to the fact that dealers here decided that as the "other countries" quota was being allocated on a first-come first-served basis they would be first-come, so that quite a respectable amount of metal has been bought in London for shipment to the U.S.A. Thanks to the higher U.S. prices transactions of this nature are profitable, even if the metal has to be warehoused until the opening of the next quota, a fate which will certainly befall any new shipments as the "other countries" quota was declared filled before the end of October. For the future a good deal hangs on the outcome of the Geneva talks on possible world regulation of supply and/or exports of lead and zinc, even though many people regard it as a foregone conclusion that nothing more startling than a committee of investigation will be produced.

U.K. August lead consumption was 21,726 tons and production 3,756 tons. Stocks rose sharply to 43,758 tons.

Zinc.—Like lead zinc has been rather firmer than many prophets expected during October—the firmness indeed being so marked that at one time zinc was a shilling or so higher than lead [1]—the first time that this relationship has obtained since the markets re-opened after the war. On top of what may be called the political influences on the market are superimposed, however, the more important factors of good demand from the U.K. motor industry and better demand from galvanized-

[1] See Table, p. 304.

sheet makers. Another factor helping zinc as well as lead has been the continued rumours of possible renewed U.S. barter activity.

U.K. August consumption was 19,076 tons, with production 5,394 tons. During the month stocks rose slightly to 49,590 tons.

Iron and Steel.—The general situation in the British iron and steel industry is unchanged. During September steel ingot and castings output was running at about 75% of capacity and it seems likely that this sort of rate will continue. Here and there mill operations have picked up, but these have often been offset by slacker conditions elsewhere. Consumers still seem to be drawing heavily upon stocks and this process is quite likely to go on for two or three months more. The total steel production in 1958 is expected to be about 19,600,000 tons, as compared with 21,700,000 tons in 1957 and a capacity of over 23,000,000 tons.

It is not only the home trade which is depressed. On the export markets demand has fallen off badly, although September figures did not show any deterioration. Exports of iron and steel in that month were over 208,000 tons, bringing the total for the year so far to 2,004,442 tons, some 15½% below the figure for the corresponding nine months of 1957. Shipments of practically the whole range of products have declined, especially bars and rods and galvanized sheets, but exports of pig-iron and of ingots and semis have shown an improvement.

Imports in September fell to their lowest level for eight years and comprised largely pig-iron and semis on outstanding contracts and ferro-alloys and uncoated sheets. Steel industry experts are inclined to be cautious of the future and, while prepared to say that there is every chance that no further serious decline in production will occur, they feel that on the strength of present indications output next year will be on a similar scale to this year's.

Iron Ore.—U.K. imports are on the decline and in the first nine months of this year fell by some 14% from the same period of 1957, totalling 9,991,854 tons, against 11,731,379 tons.

Aluminium.—At the beginning of October the U.K. Board of Trade finally made a decision regarding the question of an anti-dumping duty against imports of aluminium from the Soviet Union. The Board announced that it is not taking any further action on the application of the Aluminum Co. of Canada. Such a decision was certainly made possible by the assurance of the Russian authorities that the U.S.S.R. will not export more than 15,000 tons of aluminium to the United Kingdom in the 12 months from October 1. It is perhaps worth noting that during 1957 the U.S.S.R. exported 15,449 tons of aluminium into the U.K.; total imports in that year were 192,666 tons. In the first eight months of this year 9,579 tons of Russian metal were imported, out of a total of 130,980 tons. Exports of aluminium from Russia to the U.K. prior to 1957 were negligible. Taking these figures into consideration it is questionable whether Russian imports during the whole of 1958 would have exceeded 15,000 tons, taking into account the inhibiting effect on such trade of the anti-dumping application. In the latter part of the month some interest in Russian metal was exhibited, although supplies were not available. Even if metal from this source were available it seems likely that it would be just as expensive as metal offered in the U.K. by the leading sellers.

The question of a re-imposition of duty on imports of aluminium into Western Germany was once again raised during October and a decision is expected from the West German Economics Minister in the near future.

Consequent upon recent wage increases the prices of aluminium semis in the U.K. have risen by between 1d. and ½d. per lb. The price of ingots remains unaltered at £180 per ton.

Antimony.—During October the antimony market remained quiet, with consumer buying interest as in the previous month at a low level. The prices of Chinese and Russian metal remain unaltered, with no real market interest. English regulus is quoted at £197 10s. for 99·6% material and £190 for 99%.

Imports of antimony ore and concentrates into the U.K. during September totalled 1,299 tons, a very slight increase over the previous month.

Arsenic.—Imports of arsenic trioxide were once again down in September, totalling 600 tons as compared with 889 tons in the previous month and over 2,000 tons in July. While prices continue at the same level imports for this year continue to run at just under twice those of 1957.

The price of arsenic metal in the U.K. remains at £400 a ton and that of trioxide at £40 to £45 a ton.

Bismuth.—This metal is still quoted at 16s. per lb. and shows little sign of altering in the near future. Business is still moving at the same level as in previous months and in September imports into the U.K. totalled 96,144 lb.

Cobalt.—This has been an uneventful month for cobalt with no changes to record; the price is quoted at 16s. per lb. Imports during September totalled 136,776 lb.

Cadmium.—Following the reduction in the price of cadmium in September the market has been uneventful, with both U.K. and foreign material selling at 9s. 6d. per lb. Imports into the United Kingdom during September totalled 104,040 lb.

Chromium.—Little of interest occurred in this market during October and the price remains quoted at 6s. 11d. to 7s. 4d. per lb.

Tantalum.—There has been little activity in this market during the past four weeks and the price is still quoted at 900s. to 950s. per unit. Imports into the United Kingdom during September totalled 91 tons; this compares with only 6 tons in the previous month and 8 tons in September, 1958.

Platinum.—There were no market movements of interest during October and leading sellers of U.K. and Empire refined platinum continue to quote £21 5s. per troy oz., the price to which the metal fell in September. On the open market metal is quoted at between £18 15s. and £19 15s. per troy oz. However, in both cases business is negligible and there does not seem to be much chance of consumer buying interest reviving in the near future. During the month the Board of Trade announced that an application for a reduction in the current rate of import duty on restoring catalysts consisting of platinum and/or palladium is under consideration.

Iridium.—Nothing altered in this market during October and little consumer interest was shown. The price is still quoted at £20 to £22 per troy oz., although this is only a nominal quotation.

Osmium.—There are no signs of interest in osmium reviving and buying interest over the past four weeks has been almost non-existent. However,

the price is still nominally quoted at £17 per troy oz.

Palladium.—As with the other metals of the platinum group this metal has been without any features of interest during the month. It is still quoted at £5 to £5 15s. per troy oz.

Imports of platinum metals into the United Kingdom during September totalled only 2,782 oz., a considerable drop from the 12,543 oz. imported during August. Total imports for the January–September, 1958, period are 103,336 oz., less than half the imports in the same period of 1957.

Tellurium.—As has been the case for some months past the tellurium market has been quiet and the price remains quoted at 15s. to 16s. per lb.

Tungsten.—As was mentioned in the last report U.S. buying had given rise to the hope that things might be looking up for the tungsten ore market. During the early part of October reports became brighter and towards the end of the month prices moved up for the first time since the end of August.

Tungsten ore is now quoted at 72s. to 77s. per long ton unit of WO_3.

Nickel.—The International Nickel Co.'s properties in the Sudbury and Port Colborne areas are still strikebound, with no signs of any " back to work " movement. Consumers in this country do not seem unduly worried as, as has been mentioned previously, stocks of both nickel and the raw material for its production are at a good level in this country.

The price of nickel in this country is still quoted at £600 a ton.

Chrome Ore.—There has been little or no alteration in this market during the past month and prices are unaltered at £15 15s. for 48% Rhodesian metallurgical ore.

Imports of ore during September totalled 13,717 tons, bringing total imports into this country for the first nine months of the year to 144,646 tons, some 13,000 tons below imports in the same period of 1957.

Molybdenum.—Nothing of any interest occurred in this market until the very end of the month when reports from America indicated that a price rise was considered possible there. An increase of something like 7 cents per lb. Mo has been mentioned. It would certainly not come as a surprise if such an increase did occur considering how long the Climax strike has been on.

However, molybdenum in the U.K. is still quoted at 8s. 5d. per lb. of metal contained.

Manganese.—Following previous reports, in which it was noted that a considerable number of Indian manganese mines had been forced to close, there is every chance that such closures may become even more widespread. Effective October 1 higher freight rates on manganese ore were payable on the Indian railways and mines have protested strongly at this latest imposition.

The British Standards Institution issued a long-awaited standard in October—B.S. 3035 : 1958, the " Sampling of Manganese Ores." This publication details many aspects of sampling manganese ore and should prove of great value to all concerned in this market.

The price of manganese ore 48% is still nominally quoted at 84d. to 88d. per unit of metal contained.

Tin, Copper, Lead, and Zinc Markets

Tin, minimum 99·75% ; Copper, electro ; Lead, minimum 99·75% ; and Zinc, minimum 98%, per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Oct. 10	733 0	728 10	240 0	223 15	71 12½	73 7½	68 2½	67 7½
13	734 0	729 10	240 10	230 10	71 12½	73 2½	68 7½	67 13¾
14	736 0	730 15	238 15	232 5	73 2½	74 10	69 17½	69 2½
15	745 0	737 15	237 5	230 5	74 17½	76 12½	72 2½	70 17½
16	745 0	735 10	242 0	234 5	76 17½	77 12½	72 7½	71 7½
17	739 0	734 5	241 15	234 15	74 15	75 7½	70 17½	70 2½
20	738 0	733 5	243 10	236 15	76 12½	76 17½	71 17½	71 2½
21	742 0	736 10	250 15	243 17½	77 10	77 7½	72 7½	71 15
22	741 0	736 15	245 10	238 5	77 7½	76 17½	72 17½	71 17½
23	744 0	738 15	241 0	240 10	76 2½	75 13¾	72 7½	71 2½
24	749 0	742 5	242 0	236 7½	75 15	75 13¾	72 10	70 17½
27	747 10	744 10	246 15	239 5	76 2½	75 12½	73 7½	71 17½
28	750 0	745 10	247 10	237 15	75 17½	75 12½	74 2½	72 2½
29	751 0	745 10	247 0	236 15	75 2½	74 17½	73 7½	71 13¾
30	750 0	746 10	246 5	236 17½	73 17½	74 2½	74 0	71 12½
31	750 0	748 10	251 10	237 15	71 17½	73 7½	74 2½	71 18¾
Nov. 3	750 0	749 15	257 10	239 5	73 17½	74 2½	73 2½	71 18¾
4	750 0	749 5	256 15	239 5	74 17½	74 17½	73 2½	71 13¾
5	751 0	750 5	258 5	240 5	75 1¼	75 1¼	71 7½	69 12½
6	759 0	756 10	259 15	244 5	75 6¼	75 8¾	72 17½	71 2½
7	759 0	759 10	259 10	246 15	77 7½	77 7½	74 0	72 3¾
10	765 0	764 10	255 15	247 5	77 12½	77 12½	75 0	72 10
11	—	—	—	—	—	—	—	—

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	September		October	
	Treated Tons.	Yield Oz.†	Treated Tons.	Yield Oz.*
Blyvooruitzicht	99,000	65,647	107,000	71,227
Brakpan	121,000	16,131	124,000	16,748
Buffelsfontein‡	120,000	40,560	122,000	41,236
City Deep	115,000	23,546	114,000	23,493
Cons. Main Reef	130,000	20,061	134,000	20,610
Crown Mines	230,000	35,151	234,000	36,212
Daggafontein	239,000	49,106	234,000	48,107
Doornfontein‡	88,000	36,511	88,000	36,692
D'rb'n Roodeport Deep	186,000	33,707	191,000	34,856
East Champ D'Or‡	13,400	414	13,500	531
East Daggafontein	93,000	15,293	92,000	15,129
East Geduld	131,000	40,301	136,000	41,831
East Rand P.M.	222,000	55,405	234,000	58,261
Eastern Transvaal Consol	19,100	6,315	18,700	6,295
Ellaton‡	32,000	7,470	32,000	7,500
Freddies Consol.	54,000	14,809	57,000	14,428
Free State Geduld	74,000	53,276	74,500	54,063
Geduld	75,000	12,947	78,000	13,460
Government G.M. Areas‡	63,000	11,745	63,000	11,686
Grootvlei Proprietary	200,000	42,506	205,000	43,460
Harmony Gold Mining	100,000	40,002	104,000	42,380
Hartebeestfontein‡	87,000	47,850	87,000	47,850
Libanon	98,000	23,102	98,000	23,223
Loraine	72,000	13,898	74,000	14,430
Luipaards Vlei‡	121,000	13,316	120,000	13,437
Marievale Consolidated	78,000	20,276	81,000	20,934
Merriespruit‡	—	—	—	—
Modderfontein East	130,000	13,047	136,000	13,519
New Kleinfontein	83,000	10,703	81,000	10,918
New Klerksdorp‡	10,500	1,208	10,000	1,096
President Brand	98,000	72,323	98,000	72,473
President Steyn	98,000	37,706	94,000	37,158
Rand Leases	181,000	26,245	183,000	26,352
Randfontein‡	182,000	13,469	172,000	14,402
Rietfontein Consolid't'd.	20,000	4,706	18,000	4,584
Robinson Deep	72,000	14,706	73,500	15,350
Rose Deep	47,000	5,895	48,000	6,350
St. Helena Gold Mines	125,000	36,479	130,000	38,006
Simmer and Jack	91,000	17,028	89,500	16,902
S. African Land and Ex.	91,500	19,010	92,000	19,194
S. Roodepoort M.R.	30,000	7,028	31,000	7,075
Spaarwater Gold	10,700	3,303	10,700	3,307
Springs	130,000	15,079	130,000	15,106
Stilfontein Gold Mining‡	120,000	63,882	124,000	63,394
Sub Nigel	66,500	15,988	66,500	15,864
Transvaal G.M. Estates	12,200	1,817	11,600	1,980
Vaal Reefs‡	78,000	34,490	78,500	35,718
Van Dyk Consolidated	78,000	14,194	79,000	15,000
Venterspost Gold	130,000	32,078	130,000	32,039
Village Main Reef	26,000	4,355	27,500	4,867
Virginia O.F.S.‡	112,000	29,400	112,000	29,512
Vlakfontein	50,000	17,663	50,000	17,745
Vogelstruisbult‡	95,000	21,095	95,000	20,986
Welkom Gold Mining	91,000	27,152	90,500	27,120
West Dreifontein‡	80,000	76,437	80,000	76,518
West Rand Consol.‡	202,000	20,485	206,000	21,001
Western Holdings	100,000	56,500	100,000	57,003
Western Reefs	112,500	27,451	108,000	26,892
Witwatersrand Nigel	17,900	4,274	17,600	4,237

† 249s. 11d. * 249s. 7d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Sept.* 1957	16,699,900	64 0	45 6	17 3	24,193,575
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.*	16,198,500	64 4	46 1	18 3	23,695,380
Jan., 1958.	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.*	15,806,300	64 10	46 6	18 4	23,170,987
April	—	—	—	—	—
May	—	—	—	—	—
June*	16,435,500	64 9	46 6	18 3	24,358,945
July	—	—	—	—	—
August	—	—	—	—	—
Sept.*	—	—	—	—	25,633,898

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
November, 1957	1,386,047	36,470	1,422,517
December	1,366,354	35,789	1,402,143
January, 1958	1,377,505	40,534	1,418,039
February	1,322,843	33,879	1,356,722
March	1,394,956	36,330	1,431,286
April	1,401,094	38,352	1,439,446
May	1,435,960	36,494	1,472,454
June	1,408,384	33,187	1,447,571
July	1,456,925	42,312	1,499,237
August	1,463,259	36,413	1,499,672
September	1,465,697	36,799	1,502,496
October	—	—	1,560,726

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
February 28, 1958	326,885	30,227	357,112
March 31	333,862	31,203	365,065
April 30	337,284	31,424	368,708
May 31	337,464	31,509	368,973
June 30	334,882	31,336	366,218
July 31	336,356	31,608	367,964
August 31	334,815	31,924	366,739
September 30	333,380	31,978	365,358
October 31	335,003	—	—

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To Oct 14		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	28,000	4,607	5,765
Electrolytic Zinc	17,154	973	5,204
Lake George	18,050	1,406	2,687
Mount Isa Mines**	81,687	4,300†	2,893
New Broken Hill	54,891	5,873	9,952
North Broken Hill	34,258	7,140	7,326
Zinc Corp.	51,119	9,322	10,143
Rhodesia Broken Hill*	—	3,150†	7,700†

* 3 Mths. ** Copper 3,375 tons. † Metal.

RHODESIAN GOLD OUTPUTS

	September		October	
	Tons	Oz.	Tons	Oz.
Cam and Motor	30,969	10,236	—	—
Falcon Mines	22,000	4,249	—	—
Globe and Phœnix	6,300	3,537	6,800	3,355
Motapa Gold Mining	17,900	1,916	—	—
Mazoe	2,780	917	—	—
Coronation Syndicate	11,689	2,317	—	—
Phœnix Prince*	—	—	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	September		October	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	62,614	14,576	63,139	14,741
Ariston Gold Mines	38,140	12,427	38,550	12,448
Ashanti Goldfields	31,500	23,900	33,000	25,000
Bibiani	33,500	6,902	35,000	7,200
Bremang	—	4,706	—	—
Ghana Main Reef	11,400	4,107	11,581	4,281
Konongo	6,110	3,941	6,210	3,970
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1957		1958	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	44,337	6,134	44,305	46,553
February	41,607	5,697	43,591	21,313
March	43,831	8,179	43,830	8,179
April	46,754	6,854	46,587	22,573
May	42,650	5,606	46,015	19,937
June	46,682	6,441	46,453	20,105
July	41,922	5,781	44,244	19,170
August	44,001	5,897	47,484	20,549
September	45,762	5,677	48,295	21,141
October	46,838	5,570	—	—
November	46,987	6,331	—	—
December	45,479	5,814	—	—

WESTRALIAN GOLD PRODUCTION

	1956	1957	1958
	Oz.	Oz.	Oz.
January	66,388	106,722	66,562
February	94,638	64,949	65,965
March	66,944	67,121	65,420
April	60,415	66,435	60,855
May	62,294	64,886	64,196
June	63,570	65,142	67,929
July	69,883	74,420	81,106
August	72,303	75,727	68,610
September	62,204	64,422	68,744
October	64,594	64,524	—
November	64,113	65,700	—
December	65,031	66,562	—
Total	812,377	846,610	

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To Sept. 30		To Oct. 28	
	Tons	Oz.	Tons	Oz.
Central Norseman	14,117	7,501	13,991	7,537
Crœsus Proprietary	—	—	—	—
Gold Mines of Kalgoorlie	42,099	12,862	41,188	11,922
Golden Horse Shoe*	—	—	—	—
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	36,862	6,255	37,079	5,573
Hill 50*	39,701	18,867	—	—
Kalgurli Ore Treatment	—	—	—	—
Lake View and Star*	189,181	43,803	—	—
Moonlight Wiluna*	—	—	—	—
Morning Star (G.M.A.)	1,750	1,194	—	—
Mount Ida*	—	—	—	—
New Coolgardie	—	—	—	—
North Kalgurli	26,522	7,620	—	—
Sons of Gwalia	11,716	2,164	—	—
Mount Morgan	—	4,097	—	—

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
May, 1957	700,159	222,436	37,241	7,509,638
June	738,384	207,897	32,544	6,945,127
July	718,468	208,020	30,620	6,572,323
August	701,174	192,453	31,647	6,410,429
September	722,384	165,471	34,248	6,947,813
October	772,383	224,217	37,086	7,657,426
November	756,494	219,352	37,737	7,441,702
December	750,537	215,462	44,230	7,494,289
January, 1958	779,128	219,502	31,562	7,462,598
February	727,170	210,646	35,370	7,248,333
March	807,458	229,361	38,323	7,873,264
April	785,264	228,590	35,712	7,789,644
May	801,102	228,123	37,535	7,745,425
June	775,384	228,960	42,275	7,740,144
July	750,410	218,126	38,940	7,355,406
August	740,459	202,798	31,543	7,006,517

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	Sept.		Oct.	
	Tons	Oz.	Tons	Oz.
British Guiana Cons.	—	1,074	—	—
Central Victoria Dredging	—	—	—	—
Clutha River	—	370	—	401
Emperor Mines (Fiji)*	—	—	—	—
Frontino Gold (Colombia)	—	—	—	—
Geita Gold (Tanganyika)	—	—	—	—
Harrietville (Aust.)	—	—	—	—
Lampa (Peru)†	—	—	—	—
Loloma (Fiji)*	—	—	—	—
New Guinea Goldfields	4,234	996	—	—
St. John d'el Rey (Brazil)	—	—	—	—
Yukon Consol.	—	$424,000	—	$202,000

* 3 Months. † Ozs. Silver : Copper, 65 tons.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	Aug.	Sept.	Oct.
Ampat Tin	86½	87¼	77
Austral Amalgamated	—	—	—
Ayer Hitam	—	147*	—
Batu Selangor	—	—	—
Berjuntai	120½	102½	123
Chenderiang	—	21*	—
Gopeng Consolidated	—	101½*	—
Hongkong Tin	—	50½*	—
Idris Hydraulic	—	29*	—
Ipoh	—	—	—
Jelapang Tin	—	52½*	—
Kampong Lanjut	66	54½	38½
Kamunting	78	80	114
Kent (F.M.S.)	—	39*	—
Kepong	—	45*	—
Killinghall	—	52*	—
Kinta Kellas	—	—	—
Kinta Tin Mines	—	57*	—
Klang River	—	—	—
Kramat	44	34	52
Kuala Kampar	89	53	49
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	—	—	—
Lower Perak	106	85½	53
Malayan	—	297*	—
Malaysiam	6½	—	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	372*	—
Pengkalen	—	56*	—
Petaling Tin	—	190*	—
Puket	—	—	—
Rahman Hydraulic	—	50*	—
Rambutan	—	23*	—
Rantau	40½	38	33½
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	—	122*	—
Selayang	—	27*	—
Siamese Tin Syndicate (Malaya)	15	—	8
Southern Kinta	250½	230	223
Southern Malayan	—	464*	—
Southern Tronoh	—	—	—
Sungei Besi	—	161*	—
Sungei Kinta	—	39*	—
Sungei Way	—	206*	—
Taiping Consolidated	24	58	78
Tambah	—	—	—
Tanjong	—	126*	—
Tekka	—	19*	—
Tekka-Taiping	—	—	—
Temoh	—	14*	—
Tongkah Compound	—	—	—
Tongkah Harbour	28	27½	26
Tronoh	—	453*	—
Ulu Klang	—	—	—

* 3 months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	September		October	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	203	—	266	—
Anglo-Burma Tin	—	—	—	—
Bangrin	—	—	45	—
Beralt	71	103†	59	118†
Bisichi	59	5	53½	7
Ex-Lands Nigeria	38	—	32	—
Geevor	60	—	61	—
Gold and Base Metal	40	—	28	1
Jantar Nigeria	16	20	17¼	25
Jos Tin	10	—	—	—
Kaduna Prospectors	5	—	3	—
Kaduna Syndicate	18	—	17	—
Katu Tin	—	—	30	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	10	—	—	—
Naraguta Karama	13	—	—	—
Naraguta Tin	—	—	—	—
Renong Consolidated	—	—	—	—
Ribon Valley (Nigeria)	13¼	—	—	—
Siamese Tin Syndicate	355*	—	15	—
South Bukeru	—	—	—	—
South Crofty	65	—	65	—
Tavoy Tin	2	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	9	—	—	—

* 3 months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT
August, 1958

Gold	1,502,031 oz.
Silver	151,184 oz.
Diamonds	221,808 carats.*
Coal	3,385,106 tons.
Copper	(*a*) 67 tons in matte and copper-gold concentrates. (*b*) 5,006 tons of 19·37%.
Tin	234 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	15,295 tons.
Chrome Ore	56,010 tons.
Manganese Ore	88,585 tons.
Lead Concs.	— tons.

* July, 1958.

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		August	September
Iron Ore	tons	919,284	849,714
Manganese Ore	,,	20,222	17,280
Iron and Steel	,,	54,470	42,058
Iron Pyrites	,,	21,861	26,693
Copper Metal	,,	42,163	43,376
Tin Ore	,,	4,337	5,543
Tin Metal	,,	1,525	1,141
Lead	,,	17,848	19,636
Zinc Ore and Conc.	,,	270	—
Zinc	,,	9,572	8,796
Tungsten Ores	,,	481	409
Chrome Ore	,,	8,292	13,717
Bauxite	,,	25,000	40,261
Antimony Ore and Concs.	,,	1,161	1,299
Titanium Ore	,,	6,589	22,646
Nickel Ore	,,	2,987	2,744
Tantalite/Columbite	,,	6	91
Sulphur	,,	20,803	33,205
Barytes	,,	5,055	3,419
Asbestos	,,	9,861	11,910
Magnesite	,,	1,451	1,333
Mica	,,	570	113
Graphite	,,	280	405
Mineral Phosphates	,,	107,380	113,534
Molybdenum Ore	,,	78	290
Nickel	cwt.	2,999	45,775
Aluminium	,,	429,365	456,452
Mercury	lb.	101,882	250,552
Bismuth	,,	79,569	96,144
Cadmium	,,	118,415	104,040
Cobalt and Cobalt Alloys	,,	333,240	136,776
Selenium	,,	485	17,866
Petroleum Motor Spirit	1,000 gals.	52,549	82,622
Crude	,,	802,104	788,454

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
,, ,, 80% Technical	,,	97	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
,, Chloride, 98%	,,	26	0	0
,, Phosphate (Mono- and Di-)	,,	102	0	0
Antimony Sulphide, golden	per lb.		3	0
Arsenic, White, 99/100%	per ton	47	10	0
Barium Carbonate (native), 94%	,,	Nominal		
,, Chloride	,,	53	0	0
Barytes (Bleached)	,,	20	0	0
Benzole	per gal.		5	2
Bleaching Powder, 36% Cl.	per ton	30	7	6
Borax	,,	44	0	0
Boric Acid, Comml.	,,	75	10	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	13	5	0
Carbolic Acid, crude 60's	per gal.		8	3
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2¾
Citric Acid	per cwt.	11	0	0
Copper Sulphate	per ton	70	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, 97–98%	,,		6	6
Hydrochloric Acid 28° Tw.	per carboy		13	0
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	17	6
Lead, Acetate, white	,,	124	0	0
,, Nitrate	,,	116	0	0
,, Oxide, Litharge	,,	106	5	0
,, Red	,,	104	5	0
,, White	,,	116	0	0
Lime, Acetate, brown	,,	40	0	0
Magnetite, Calcined	,,	20	0	0
,, Raw	,,	9	0	0
Magnesium Chloride, ex W'h'se	,,	16	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	3
Nitric Acid, 80° Tw.	per ton	37	10	0
Oxalic Acid	,,	129	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Pine Oil	per ton	Nominal		
Potassium Bichromate	per lb.		1	2¼
,, Carbonate (hydrated)	per ton	74	10	0
,, Chloride, 96%	,,	21	0	0
,, Iodide	per lb.		9	0
,, Amyl Xanthate	,,	Nominal		
,, Ethyl Xanthate	,,	Nominal		
,, Hydrate (Caustic) solid	per ton	118	0	0
,, Nitrate	per cwt.	4	1	0
,, Permanganate	per ton	193	10	0
,, Sulphate, 48%	,,	22	1	0
Sodium Acetate	,,	99	0	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	15	0	0
,, Bichromate	per lb.		1	0
,, Carbonate (crystals)	per ton	Nominal		
,, ,, (Soda Ash) 58%	,,	13	5	0
,, Chlorate	,,	92	0	0
,, Cyanide 100% NcAN basis	per cwt.	6	6	6
,, Hydrate, 76/77%, solid	per ton	33	0	0
,, Hyposulphite, Comml.	,,	32	15	0
,, Nitrate, Comml.	,,	29	10	0
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0¾
,, Silicate	per ton	11	0	0
,, Sulphate (Glauber's Salt)	,,	9	15	0
,, ,, (Salt-Cake)	,,	8	0	0
,, Sulphide, flakes, 60/62%	,,	37	2	6
,, Sulphite, Comml.	,,	27	10	0
Sulphur, American, Rock (Truckload)	,,	16	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	10	10	0
,, ,, free from Arsenic, 140° Tw.	,,	8	0	0
Superphosphate of Lime, 18% P_2O_5	,,	14	18	6
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	104	0	0
,, Oxide	,,	88	10	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	Oct. 7, 1958 £ s. d.	Nov. 10, 1958 £ s. d.
SOUTH AFRICA:		
Blinkpoort (5s.)	2 11 9	2 10 0
Blyvooruitzicht (2s. 6d.)	1 4 0	1 2 9
Brakpan (5s.)	4 9	5 0
Buffelsfontein (10s.)	2 2 6	2 2 9
City Deep	13 9	15 6
Consolidated Main Reef	16 3	17 3
Crown Mines (10s.)	1 4 6	1 6 3
Daggafontein (5s.)	1 9 3	1 11 3
Dominion Reefs (Ord. 5s.)	15 3	16 0
Doornfontein (10s.)	1 7 3	1 9 0
Durban Roodepoort Deep (10s.)	1 8 3	1 10 6
East Champ d'Or (2s. 6d.)	1 9	1 9
East Daggafontein (10s.)	8 6	8 9
East Geduld (4s.)	1 4 6	1 4 6
East Rand Proprietary (10s.)	1 18 6	1 19 6
Freddies Consol.	2 6	2 6
Free State Dev. (5s.)	5 6	6 9
Free State Geduld (5s.)	4 17 0	5 8 0
Free State Saaiplaas (10s.)	18 0	14 6
Geduld	3 2 6	3 3 9
Government Gold Mining Areas (5s.)	3 6	3 6
Grootvlei (5s.)	15 3	16 3
Harmony (5s.)	1 19 0	1 18 0
Hartebeestfontein (10s.)	3 6 6	3 3 6
Libanon (10s.)	8 3	8 3
Loraine (10s.)	3 6	3 6
Luipaards Vlei (2s.)	10 3	10 3
Marievale (10s.)	1 0 3	1 2 3
Merriespruit (5s.)	5 9	5 0
Modderfontein B (3d.)	3 3	3 6
Modderfontein East	14 6	14 0
New Kleinfontein	4 3	4 0
New Pioneer (5s.)	1 19 9	2 0 0
New State Areas (15s. 6d.)	1 6	1 6
President Brand (5s.)	2 17 6	3 2 3
President Steyn (5s.)	1 8 3	1 8 9
Rand Leases (10s.)	4 6	5 0
Randfontein	1 3 3	1 5 3
Riebeeck (10s.)	1 1 9	1 2 3
Rietfontein (4s.)	7 6	6 6
Robinson Deep (6s.)	8 6	8 0
Rose Deep (6s. 6d.)	11 6	13 6
St. Helena (10s.)	2 4 6	2 4 0
Simmer and Jack (2s.)	3 3	3 3
South African Land (3s. 6d.)	1 2 0	1 3 0
Springs (5s.)	1 9	1 9
Stilfontein (5s.)	2 4 0	2 4 6
Sub Nigel (10s.)	13 3	14 3
Vaal Reefs (5s.)	1 17 6	1 18 3
Van Dyk (7s. 9d.)	3 6	3 6
Venterspost (10s.)	14 9	15 3
Virginia (5s.)	8 3	8 3
Vlakfontein (10s.)	15 9	16 0
Vogelstruisbult (10s.)	8 6	10 3
Welkom (5s.)	18 0	1 1 6
West Driefontein (10s.)	5 6 3	5 7 9
West Rand Consolidated (10s.)	1 4 6	1 5 3
West Witwatersrand Areas (2s. 6d.)	2 7 9	2 7 3
Western Holdings (5s.)	5 3 6	5 8 0
Western Reefs (5s.)	1 9 0	1 8 9
Winkelhaak (10s.)	17 9	18 9
Witwatersrand Nigel (2s. 6d.)	1 3	1 3
RHODESIA:		
Cam and Motor (2s. 6d.)	9 0	8 9
Chicago-Gaika (10s.)	16 3	16 3
Coronation (2s. 6d.)	3 9	4 3
Falcon (5s.)	7 3	7 6
Globe and Phœnix (5s.)	1 10 0	1 9 6
Motapa (5s.)	6	4½
GOLD COAST:		
Amalgamated Banket (3s.)	1 0	1 0
Ariston Gold (2s. 6d.)	4 3	4 3
Ashanti Goldfields (4s.)	16 0	17 3
Bibiani (4s.)	2 0	2 3
Bremang Gold Dredging (5s.)	1 3	1 3
Ghana Main Reef (5s.)	1 9	1 9
Konongo (2s.)	1 8	1 6
Kwahu (2s.)	3 0	2 9
Taquah and Abosso (3s.)	—	—
Western Selection (5s.)	5 3	5 0
AUSTRALASIA:		
Gold Fields Aust. Dev. (3s.), W.A.	1 9	1 9
Gold Mines of Kalgoorlie (10s.)	8 3	8 6
Great Boulder Propriet'y (2s.), W.A.	12 3	12 6
Lake View and Star (4s.), W.A.	1 3 9	1 3 0
London-Australian (2s.)	7	9
Mount Morgan (10s.), Q.	8 6	10 3
New Guinea Gold (4s. 3d.)	1 9	1 9
North Kalgurli (1912) (2s.), W.A.	8 0	8 9
Sons of Gwalia (10s.), W.A.	2 0	2 0
Western Mining (5s.), W.A.	8 6	8 9

MISCELLANEOUS:	Oct. 7, 1958 £ s. d.	Nov. 10 1958 £ s. d.
Fresnillo ($1·00)	2 0 0	1 18 9
Kentan Gold Areas (1s.), E. Africa	3	8
St. John d'el Rey, Brazil	2 15 6	2 19 3
Yukon Consolidated ($1)	4 5	4 6
COPPER:		
Bancroft Mines (5s.), N. Rhodesia	1 1 3	1 4 0
Esperanza (2s. 6d.), Cyprus	1 6	1 7
Indian (2s.)	5 0	5 3
MTD (Mangula) (5s.)	7 6	8 9
Messina (5s.), Transvaal	4 16 3	5 15 0
Mount Lyell, Tasmania	1 0 9	1 2 9
Nchanga Consolidated, N. Rhodesia	11 8 9	11 18 9
Rhokana Corporation, N. Rhodesia	29 15 0	29 10 0
Roan Antelope (5s.), N. Rhodesia	9 0	8 9
Tanganyika Concessions (10s.)	3 2 0	3 3 0
LEAD-ZINC:		
Broken Hill South (5s.), N.S.W.	2 5 0	2 6 9
Burma Mines (3s. 6d.)	1 9	1 9
Consol. Zinc Corp. Ord.	2 13 3	2 18 0
Electrolytic Zinc, Tasmania (Pref. 5s.)	2 12 6	2 12 6
Lake George (5s.), N.S.W.	4 3	4 6
Mount Isa, Queensland (5s. Aust.)	1 5 0	1 6 9
New Broken Hill (5s.), N.S.W.	1 15 6	1 19 0
North Broken Hill (5s.), N.S.W.	3 16 3	3 15 0
Rhodesia Broken Hill (5s.)	9 0	9 3
San Francisco (10s.), Mexico	1 0 0	19 0
TIN:		
Amalgamated Tin (5s.), Nigeria	5 9	6 6
Ampat (4s.), Malaya	7 0	7 3
Ayer Hitam (5s.), Malaya	1 6 0	1 9 0
Beralt (5s.), Portugal	1 5 6	1 12 3
Bisichi (2s. 6d.), Nigeria	2 9	3 3
Ex-Lands (2s.), Nigeria	1 9	2 0
Geevor (5s.), Cornwall	15 9	16 3
Gold Base Metals (2s. 6d.), Nigeria	9	9
Hongkong (5s.), Malaya	4 3	4 3
Jantar Nigeria (3s.)	2 3	3 3
Kaduna Syndicate (2s.), Nigeria	2 3	2 1½
Kamunting (5s.), Malaya	9 3	10 9
Kramat Pulai (3d.), Malaya	5 3	5 3
Malayan Tin Dredging (5s.)	11 0	12 3
Mawchi Mines (4s.), Burma	1 9	2 0
Naraguta Extended (5s.), Nigeria	9	9
Pahang (5s.), Malaya	4 9	5 0
Siamese Synd. (5s.)	7 3	8 0
South Crofty (5s.), Cornwall	3 3	3 6
Southern Kinta (5s.), Malaya	17 9	18 9
Southern Malayan (5s.)	9 9	10 9
Southern Tronoh (5s.), Malaya	8 6	10 3
Sungei Besi (4s.), Malaya	14 3	14 6
Sungei Kinta, Malaya	13 0	13 6
Tronoh (5s.), Malaya	11 3	11 6
United Tin Areas (2s. 6d.), Nigeria	5	6
DIAMONDS:		
Anglo American Investment	9 17 6	10 15 0
Consol African Selection Trust (5s.)	16 9	17 3
Consolidated of S.W.A. Pref. (10s.)	11 0	10 9
De Beers Deferred (5s.)	5 11 9	5 17 6
FINANCE, ETC.		
African & European (10s.)	3 10 3	3 15 0
Anglo American Corporation (10s.)	7 17 6	8 1 3
Anglo-French Exploration	1 4 0	1 5 0
Anglo Transvaal 'A' (5s.)	1 16 6	1 18 6
British South Africa (15s.)	3 14 9	3 12 0
British Tin Investment (10s.)	17 3	19 3
Broken Hill Proprietary	1 18 6	1 18 6
Camp Bird (10s.)	17 3	12 9
Central Mining	3 6 9	3 6 3
Central Provinces Manganese (10s.)	1 9 6	1 10 9
Consolidated Gold Fields	2 14 0	3 1 6
Consolidated Mines Selection (10s.)	1 15 3	1 18 3
East Rand Consolidated (5s.)	1 6	1 6
Free State Development (5s.)	5 6	6 9
General Exploration O.F.S. (2s. 6d.)	4 9	4 6
General Mining and Finance	4 17 6	5 0 0
H.E. Proprietary (5s.)	12 9	14 3
Johannesburg Consolidated	2 5 9	2 11 6
London & Rhod. M. & L. (5s.)	8 0	7 0
London Tin Corporation (4s.)	8 0	8 0
Lydenburg Est. (5s.)	15 0	16 9
Marsman Investments (10s.)	1 4½	1 3
National Mining	1 6	1 9
Rand Mines (5s.)	4 3 0	4 5 0
Rand Selection (5s.)	2 3 6	2 4 3
Rhodesian Anglo American (10s.)	3 17 6	3 16 3
Rhodesian Corporation (5s.)	3 9	3 9
Rhodesian Selection Trust (5s.)	18 3	18 3
Rio Tinto (10s.)	3 0 0	2 18 3
Selection Trust (10s.)	4 16 9	4 13 9
South West Africa Co. (3s. 4d.)	13 9	13 9
Union Corporation (2s. 6d.)	2 3 0	2 4 3
West Rand Inv. Trust (10s.)	2 9 0	2 10 6
Zambesia Exploring	2 5 6	2 3 9

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Open-Pit Blasting with Ammonium Nitrate

An account of "Pit Operations at the Marmoraton Mine, Hastings County, Ontario," by C. A. Lorenson and J. S. K. McChesney, appears in the *Canadian Mining and Metallurgical Bulletin* for September. The Marmora ore-body is a replacement of Precambrian limestone with zones or bands of magnetite interlaid with metamorphic rocks and cut by later intrusives. The ore and associated Precambrian rocks are overlain by 100 ft. to 150 ft. of flat-lying Palaeozoic limestone. It is a low-grade deposit averaging 33% iron and requires concentration to raise it to 65% iron grade.

The removal of over 20,000,000 tons of Palaeozoic limestone was started in May, 1952, and by March, 1955, the capping had been removed and an ore face developed for mining. Two electric rotary drills, using 6¾-in. tricone bits, were employed in drilling the blast holes. The holes were spaced on a 25 ft. by 25 ft. pattern, with the face varying in height from 45 ft. to 83 ft. The drilling rate averaged 20 ft. to 25 ft. per hour, with a bit life averaging 1,300 ft. per bit. The drills operated 24 hours per day, five days per week.

Primary blasting was done with 5 in. by 16 in. cartridges of 50% to 60% ammonium dynamite, using wire-countered primacord in the holes and electric millisecond delay caps from 0 to 8 as detonators on the surface. Four and a half tons of limestone were broken per lb. of powder and very little secondary blasting was required.

The blasted material was loaded by three electric shovels equipped with 6-cu. yd. dippers into 22-ton capacity diesel trucks. The trucks were powered by 300-h.p. engines equipped with torque converters, semi-automatic transmission, shutters, heaters and de-frosters for cabs, and rock ejectors for the rear wheels. Fifteen trucks operated each shift, which left six trucks as spares for servicing.

Until December, 1956, 5 in. by 24 in. and 6 in. by 24 in. canned ammonia-type powder was used for primary blasting, with the higher-density powder, water-resistant pellets, and the 5 in. by 24 in. primer in the bottom of the hole and the less dense canned powder above. Wire-bound primacord is fastened to the primer and millisecond delays are used on the surface as detonators. Double-row shooting has been found very effective and is now used more often than single-row.

Ammonium nitrate as a blasting agent was first developed and used commercially by Robert Akre, Superintendent of Drilling and Shooting for the Maumee Collieries Company, Terre Haute, Indiana, and was given the name "Akremite." It consisted of a mixture of 5% carbon black with granular ammonium nitrate and was packed in a polyethylene bag. From its success in the coalfields its use spread to limestone quarries, open-pit iron mines, and copper mines. Instead of mixing the carbon black with the ammonium nitrate various mining companies experimented with adding fuel oil in varying amounts to the ammonium nitrate prills, the fuel oil supplying the necessary carbon to form more gas from the excess oxygen available in an ammonium nitrate decomposition reaction. It was found through experiment that the best results seem to be obtained with a mixture of 1 gal. of fuel oil with an 80-lb. bag of fertilizer-grade ammonium nitrate.

The general procedure in loading blasting holes at the Marmoraton mine is as follows: Two 6-in. diameter cans of Nitrox are lowered and approximately 25 lb. of water-resistant Nitropel are poured in to fill the void around the cans. The 5-in. diameter primer-can, attached to a wire-bound primacord fastened at the surface, is then introduced. If the hole is dry ammonium nitrate mixed with fuel oil replaces Nitrone T-1 pound for pound. If the hole has water in it cans of Nitrone T-1 are added until the column of explosive is above the water level. A 4 in. by 24 in. primer is then added, the voids around the cans are filled with stemming (drill-hole cuttings), and the ammonium nitrate is added. The explosive charge is topped off with a 4 in. by 10 in. primer or a 4 in. by 24 in. primer, attached to a wire-bound primacord fastened at the surface. Stemming is then added to fill the remainder of the hole to the surface, usually about 14 ft. The primacord downlines are tied to the main line and then the hole is ready for whatever millisecond delay cap is called for in the cap arrangement and blast hook-up.

Ammonium nitrate is shipped in heavy-weight, 3-ply paper bags. It comes in prill form, the prills being approximately $\frac{3}{32}$ in. in size. The care and handling of ammonium nitrate should be no different than that of other explosives.

Where large quantities of ammonium nitrate are stored (over 123 tons) the storage recommendations from the proceedings of the conference on ammonium nitrate fertilizer of the National Research Council of Canada should be followed.

Two of three 4½-cu. yd. electric shovels are operated at a time in the open pit, one generally in ore and the other in stripping, working two eight-hour shifts five days per week. Operations begin with the middle shift starting work at 4 p.m. on Monday and terminating with the day shift on Saturday at 4 p.m. This method of scheduling permits repairs to the pit equipment on the Monday day shift and

allows the stockpile to be large enough to carry feed over the weekend for the secondary crushing plant.

The shovel crew consists of an operator, oiler, and spotter. The spotter's duty is to remove any stones that may have fallen near the trucks, which would damage the tyres.

The power-feed cable for the shovels is carried on a platform fastened to the back of the shovel undercarriage. This facilitates the moving of the shovel without the use of auxiliary equipment. Clean-up at the shovels is mostly done with a *D*-8 tractor. Eleven 22-ton trucks are used on each shift, four being assigned to ore production and seven to stripping production. If both shovels are in stripping, the trucks are split five and six.

In ore production loading averages 413 tons per hour and in stripping 434 tons per hour.

The haulage road out of the pit for the waste rock is at an 8% grade to the pit entrance and from there to the waste dumps at a 5% grade. The ore at the present time is hauled upgrade to the pit loading pocket, where the trucks are end-dumped into the side of the skip. Present plans call for extending the incline skipway two levels, a distance of 90 ft. vertically.

The ore is hoisted up the 45° incline in two 22-ton skips. The hoist is a 12-ft. diameter double-drum hoist and is powered by a 1,250-h.p. a.c. motor. Each skip is equipped with two $1\frac{3}{4}$-in. diameter ropes fastened to an equalizer yoke. Maximum rope speed is 800 ft./min. Times of acceleration and deceleration are 9 seconds and 13 seconds respectively. The ore at present is being hoisted a distance of 275·42 ft. up a 45° incline, or 194·75 ft. vertically.

The hoist operator is located at a vantage point at the top of the skipway, where he can observe the loading of the skips at the loading pocket and the dumping of the skips into the primary crusher.

Deep Mine Ventilation in South Africa

The following notes are abstracted from the address of M. Barcza, the president of the South African Institute of Mining and Metallurgy, published in the *Journal* for August. The president reviewed "The Ventilation of Gold Mines in South Africa," discussing "Achievements of the Past and Problems of To-day." In respect of the method and economy of air cooling he briefly examined the technical and economic implications of mining at around 12,000 ft. on the Central Rand, where the rock temperatures will be about 130° F.

To ventilate at depth is mainly an economic problem. The president said that there are many possible approaches to the estimation of ventilation requirements in deep stopes. His method was to assume a practicable velocity at the stope face and a maximum permissible wet-bulb temperature; then, basing calculations on certain assumptions and practical considerations, to determine the length of stope face which can be ventilated before the wet bulb reaches the maximum. From this the required cooling and thus the capital and operating cost of the whole ventilation scheme can be calculated. Practical experience gained on some of the deep mines of the Central Rand indicates that 25,000 cu. ft./min. appears to be a reasonable volume target for a stope face. With such volumes, velocities at the face should be of the order of 500 ft. to 600 ft. per min.

He asked what should be regarded as the maximum acceptable wet-bulb temperature with this air velocity of 500 ft./min. to 600 ft./min. First the physiologists and psychologists must establish the relationship between wet-bulb temperature and work output in practice. Secondly, the engineers must establish the relationship between wet-bulb temperature and total ventilation costs. Without this precise information he regarded 92° F. wet bulb as an acceptable maximum temperature, with a velocity of 500 ft./min. to 600 ft./min.

The next step was to determine the length of stope face which can be ventilated before the wet-bulb temperature reaches 92° F. With any given air volume and velocity the length will depend mainly on the following factors: The virgin-rock temperature, the rate of face advance, the degree of wetness, and the difference between the virgin-rock temperature and the initial wet- and dry-bulb temperatures. Rock temperatures can be estimated with some confidence, although at great depth there exist certain anomalies in the temperature gradient. It would appear that on some mines of the Central Rand the rock-temperature gradient steepens between 9,000 ft. and 11,000 ft. and also variations appear to take place over comparatively short-strike distances. For the purpose of review the virgin-rock temperature at 12,000 ft. is estimated to be 130° F.

The rate of face advance has a considerable bearing on the heat flow from the rock to the air. The shape of the rate of heat-flow curve will be exponential, but it is not known in which part of this curve the present rate of face advances of 10 ft. to 20 ft. per month lie, although it does seem to indicate that the heat flow is not in direct proportion to the face advance. It is thus convenient and to some extent justified to exclude the rate of face advance from the necessarily rough calculations. With reference to the degree of wetness, although dry or at least drier mining would be highly desirable, no radical departure from wet-mining methods is envisaged. This is because of lack of convincing data as to the cost of dry mining and also in order to keep the deliberations on a realistic basis.

The last step, said the president, should be to assume wet- and dry-bulb temperatures at the bottom of the stope and then to estimate the length of stope face. He suggested that 300 ft. of stope face is a suitable unit of length on which to base the ventilation methods envisaged at great depth. Therefore his final estimate, based on the limited amount of published data and some unpublished results of observations, was as follows:—

If air can be introduced at the bottom of a stope at 86° F. saturated, when the V.R.T. is 130° F., then with 25,000 cu. ft./min. flowing up the stope face at 500 ft./min. to 600 ft./min. velocity the

temperature of the wet bulb will not rise above 92° F. at the end of the 300-ft. face. To obtain an initial temperature of 86° F. wet bulb it will be necessary to cool the air near the stope face, therefore the air will be practically saturated and the dry-bulb temperature can be assumed to be the same as the wet-bulb temperature. Since it does not pay to cool the air to such a degree that the temperature difference between the air and the rock would be very great, the most expedient way of ventilating the mine would be to supply air at a reasonably high wet-bulb temperature—such as, the 86° F. suggested—and to depend on ventilating comparatively short lengths of stope faces before recooling or discarding the air.

The most important technical problem and also the most expensive item will be air cooling. The best way of estimating the cooling requirements and cooling costs is to express these per unit length of face. This basis will hold good whether air is re-cooled or sent to return after 300 ft. of face. It will hold good for both long-wall and scattered stoping methods. The cooling required will be the same, because without cooling it is unlikely that at 12,000 ft. depth the air can be brought to the bottom of the stope much below 92° F. wet-bulb temperature. With the stated temperature conditions 60 tons of refrigeration will be required for each 300-ft. long stope face or, in other words, 1 ton of refrigeration (200 B.Th.U./min.) would enable the mining of 5 ft. of stope face.

The cooling system envisaged will be as follows: Cooling plants with capacities up to 1,000 tons of refrigeration will be situated in central positions underground. Heat rejection will be into return air or into water pumped to surface. The cold water will be piped in a closed circuit to high-pressure heat exchangers. These will be situated near the shaft stations on the various stoping levels. From these high-pressure heat exchangers low-pressure secondary circuits will carry the cold water to the stope faces. The total installed cost of the centrally-situated cooling plant, together with the insulated piping necessary to transmit the cold water from the plant to the stopes, is estimated to be £200 per ton of refrigeration. Thus the capital cost of the air-cooling plant per foot of stope face will be about £40. Taking the life of a cooling plant as 15 years and assuming 5% interest, the capital amortization per month per foot of face will be 6s. 3d. The power required for compressors and pumps will be approximately 2 h.p. per ton of refrigeration. The cost of this power will be 8s. 9d. per foot of face per month.

Thus the capital amortization and working costs will be 15s. per foot of face per month. Assuming 4 ft. stoping width and 15 ft. per month face advance 5 tons of rock would be produced per month per foot of stope face. The capital amortization and basic air-cooling cost would thus be 3s. per ton and, allowing for maintenance and sundry costs, probably 3s. 6d. per ton. With 30 ft. per month face advance this cost could be very nearly halved. From the cooling costs point of view it is of little consequence whether the 25,000 cu. ft./min. is recooled or sent to return after it has ventilated a 300-ft. long stope face. It would therefore be possible to ventilate any number of stope faces with a total volume of 25,000 cu. ft./min.

There are three important factors which make this unrealistic, the president said: The problem of heat disposal from the cooling plant, the ventilation of the tramming levels, and the probable build-up of dust. If air is used to remove the heat from the cooling plant the basis of calculating the air required will be the rate of stope-face advance. From the figures quoted it can be calculated that with 15 ft. per month face advance, one twenty-fifth of a ton of refrigeration will be required for 1 ton of rock per month. With the cooling plants and refrigerants available at present reasonable efficiencies can be obtained with 250 cu. ft./min. cooling air per ton of refrigeration. Therefore with 15 ft. per month face advance 10 cu. ft./min. of condenser-water cooling air will be required for each ton of rock mined per month. This is one basis on which to calculate the air requirements at very great depth. The basis is not the downcast but the upcast (heat rejection) requirements. The other problem will be the ventilation of the tramming levels and possibly of scraper paths. These will either require additional splits of air from the shaft or return air which has been cooled. Thus probably the ultimate layout will make provision for a small volume of air (25,000 cu. ft./min.) to ventilate a number of stope faces in series, this air being re-cooled on every level. Special splits will be established on all tramming levels. A long-wall method of stoping would facilitate the introduction of this system, whereas with scattered stoping it would be more difficult.

With long-wall stoping and good air control either some of the air might have to be sent down solely for cooling the condenser water or alternatively, if less air were available for water cooling, then plant efficiencies would be materially lowered. Possibly water could be piped down from surface in a closed circuit merely to remove the heat from the cooling plants. In order to evaluate the relative economy of sending air or water down for heat rejection purposes a careful study will have to be made of the technical difficulties and the energy requirements of the various schemes. It is known that the efficiency of cooling plants decreases at high condensing temperatures, also the mechanical design of the cooling plants is generally not well suited to work at exceptionally high condensing temperatures. Yet it is possible that it would be more economical to work at higher condensing temperatures, thus requiring a smaller mass of air or water for heat rejection than to face the costs of supplying these media in larger quantities.

The general layout and cooling method envisaged contains no element which is basically new or which has not been tried in one or other of the mining fields. The air-cooling cost at 12,000 ft. will be of the order of 3s. 6d. per ton, of which 1s. 3d. will be capital redemption. The total ventilation costs—excluding capital redemption—are expected to be in the vicinity of 4s. 6d. per ton. Even to-day, if on the deep mines of the Rand Mines Group the air-cooling costs were to be debited only to those tonnages which are mined in cooled areas and not distributed over the total tons mined, then the ventilation costs in the deep areas would already be approximately 2s. 9d. per ton (1s. 7d. ventilation costs and 1s. 2d. air-cooling costs).

Concerted efforts, said the president, should be made in two general directions. The one is improved rate of face advance. The other is a more complete understanding of the heat flow from the rock and the study of the performance of cooling plants and of their application.

Expansion at the Manitoba–Saskatchewan Border

An article in the *Precambrian* for September gives a brief review of the operations of the Hudson Bay Mining and Smelting Co., Ltd., at the Flin Flon concentrator, going on to deal with the new areas now being brought to production. It is noted that the company has continued its active prospecting and exploration work in the general vicinity of Flin Flon and in 1956 discovered two new mineral deposits of major significance near the town of Snow Lake, Manitoba, one of which is at Chisel Lake, 5 miles to the south-west and the other at Stall (Miller Lake), 4 miles south-east of the town. Exploration work on these properties up to the present has been done by diamond drilling but shaft sinking and underground development work are now in progress. Access roads have been built from the Wekusko–Snow Lake road to the properties and power lines are also being erected. The Chisel Lake property has predominant zinc values with lesser amounts of gold, silver, copper, and lead while the Stall Lake property has predominant copper with lesser amounts of other metals. The company also owns another copper-zinc property at Osborne Lake, which is located 12 miles north-east of Stall Lake. It has been developed thus far by diamond drilling.

Production from this new area will be treated at Flin Flon. Known ore reserves will extend operations at that point by many years. In addition to the discoveries already made in the Snow Lake area the company has staked or has options on claims covering a very large area on which an intensive programme of exploration work is being carried on in the search by geophysical methods and diamond drilling for additional ore deposits. The recent discovery of sizeable base-metal ore deposits in this new district represents one of the major mining discoveries of recent years in Manitoba.

Hudson Bay also has other base-metal developments within a 15-mile radius of Flin Flon. Of these, Schist Lake mine, 3½ miles south-east of the town, is in the production stage and ore is being trucked to the mill at Flin Flon. There are two company mines in Saskatchewan—Birch Lake, 9½ miles south-west of the town and Coronation, 4 miles beyond that. A new 14-mile standard-gauge railway to Coronation mine from Flin Flon is now completed.

The company spent $20,500,000 on its original mine, metallurgical plant, and hydro-electric plants and another $30,000,000 for plant additions to date. The present payroll is over $12,000,000 per year and the annual cost of materials for maintenance, repairs, and operation totalled $8,000,000, while about $11,000,000 was paid in taxes and royalties. This great wealth plays an important part in the Canadian economy. Manitoba and Saskatchewan have profited greatly by the development which has provided new sources of revenue and homes for a town of more than 14,000 people. For the past year the company has been exceptionally busy on shaft sinking jobs and at least three of the four shafts being sunk or deepened are on the verge of completion.

The Schist Lake shaft was deepened and a new hoist installed so as to enable the development of an ore-body located below the 1,100-ft. level. Exploration drives are now being driven and an increased amount of activity is seen around this mine.

At Coronation a new shaft is nearing completion. This will be known as the No. 2 shaft and will be used solely for the hoisting of men and the handling of supplies, leaving the main shaft for the exclusive purpose of hoisting ore. The Chisel Lake shaft is also just about completed and a lot of development is planned for this mine. Sinking at the Stall Lake mine has been restarted after a lapse of time during which the permanent headframe and hoistroom have been erected and it will be quite a long time before this shaft is completed.

Uranium Production

The following notes on world uranium production are abstracted from an article appearing in the *Western Miner and Oil Review* for September. There it is stated that in 1957 the major share of uranium production in the Free World came from United States, Canada, and South Africa, with lesser quantities from the Belgian Congo, Australia, France, Portugal, and Northern Rhodesia. The increase in Canadian production to 6,438 tons of U_3O_8 in 1957 raised Canada from third to second place after the United States. Year-end milling capacity in the Dominion totalled 21,200 tons a day. On the basis of an average grade of 2·5 lb. per ton, the industry was capable of producing 26·5 tons of precipitate a day. This will be substantially increased in 1958.

In 1957 the United States increased its production to an estimated 9,200 tons of U_3O_8 and remained the largest producer of uranium for the second successive year. At June 30, 1957, 11 ore-producing mills were in operation with a capacity to treat ore equal to 8,610 tons a day and ten mills with a total rated capacity of 9,375 tons a day were under construction. With completion of these mills the capacity to treat ore will be raised to 17,705 tons a day.

South Africa's production during 1957 totalled 5,669 tons of U_3O_8. This came from 27 mines feeding 17 treating plants. In 1956, 4,250 tons of precipitate were produced. One new mine came into production during the year, increasing the industry's capacity to treat ore to 62,167 tons a day. South Africa's U_3O_8 producing capacity at the end of 1957 was equal to about 15·5 tons a day.

Production from the Belgian Congo's Shinkolobwe mine is not published. A treatment plant with a rated capacity of 8,000 tons a day was built after World War II.

Although no official total for production from Australia has been reported it is estimated that the 1957 production was about 475 tons of U_3O_8. Two mines feeding two processing plants with a

total capacity of 335 tons a day were in operation. A third mill and plant with a rated capacity of 1,100 tons a day were under construction.

France is the leading producer of uranium in Western Europe. In 1957 production amounted to 500 tons of U_3O_8 from two chemical leaching plants having a total rated ore-treating capacity of about 550 tons a day. One plant is to be enlarged and another is under construction.

Portugal has some production in its northern region, but production and operating statistics have not been released.

A small ore-treating plant in Northern Rhodesia commenced production in 1957 to treat ore from the Nkana mine.

Production of uranium in Canada is directed almost exclusively to fulfilling commitments to the United States. In 1957 exports to that country were valued at $127,934,004. Contracts between the governments of United States and Canada, as well as between the governments of United States and South Africa, Belgian Congo, and Australia were negotiated to assure that all military requirements would be met. At the time of the negotiations the civilian nuclear power industry was not in being. It is only now beginning to make itself felt. Of the countries interested in this new form of power only the United Kingdom has embarked upon a programme which will assure nuclear-powered electricity a significant share of the nation's emergency output and consumption of appreciable quantities of uranium for peaceful purposes. Outside of the military programme it is undoubtedly nuclear power that holds the greatest promise for large consumption of uranium.

Uranium can also be used to fuel reactors for other purposes. Nuclear power now propels submarines and there is little doubt that it will be used in other types of marine craft. Uranium can be used to generate steam for industrial purposes and to heat entire communities remote from supplies of conventional fuel. Radioactive isotopes are being produced in reactors throughout the world. Uranium will eventually find its way into other fields but these are unlikely to require the quantities that will be needed to supply a uranium-based nuclear-energy industry.

Eldorado Mining and Refining, Limited, a Crown agency, is the sole buyer of uranium in Canada. The corporation buys uranium ores and concentrates at the maximum rate of $7·25 a lb. of contained uranium oxide. All uranium to date, however, has been procured through special contracts with companies that produce chemical precipitates and all contracts so far negotiated are confined and vary with the companies. They are based on amortization of preproduction expenses, recoverable ore grades, estimated operation costs, and a profit allowance. A commonly quoted price, $10 a lb., represents a reasonable average.

The average unit cost of uranium delivered to United States during the fiscal years 1956 and 1957 is shown below. These costs include bonus payments for initial production of uranium ore. From U.S. sources, $11·96 (1956), $10·80 (1957); from other countries, $10·94, $11·18, and from all sources $11·35, $11·00.

There is no tariff on uranium entering the United States. At the end of 1957 there was no tariff on uranium entering Canada, but after June 30, 1958, there was a 15% customs duty on uranium pig, ingot, billet, and bars.

Trade Paragraphs

Eutectic Welding Alloys Co., Ltd., of Faggs Road, Feltham, Middx., have compiled a wall chart giving the main uses and properties of their range of metal-joining alloys and electrodes.

Austin Hopkinson and Co., Ltd., of Audenshaw, Manchester, announce that the address of their Export Division is now 20, Quai d'Orléans, Paris IVe (telephone: Médicis 3596). Mr. G. Drury Baker continues in management.

Hadfields, Ltd., of Sheffield, have just issued a new publication on Esco earth-moving equipment. This is particularly devoted to dragline buckets and shovel dippers such as they manufacture but also to dozer rooters, tooth adaptors, trencher teeth, and other accessories.

Pollard Bearings, Ltd., of Ferrybridge, Knottingley, Yorks., have recently published a useful book of interchangeability tables containing Pollard reference numbers of roller-bearings for tractor and like equipment with the corresponding American-made bearings used in such machinery.

Airtech, Ltd., of Haddenham, Bucks., have produced a leaflet which describes the Aircon transportable container. Among many applications suggested for this are living accommodation, office, or workshop for persons engaged in surveying, prospecting, or other engineering work in out of the way places.

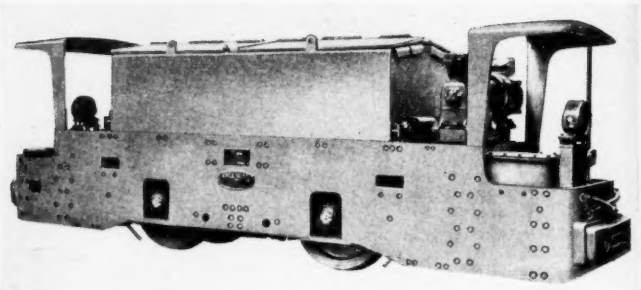
Richard Hill, Ltd., of Middlesbrough, have recently issued a leaflet giving particulars of their Maxweld screen cloth made from hard drawn steel wire in sizes from 10 s.w.g. up to $\frac{3}{8}$ in. diameter bar for meshes from $\frac{3}{8}$ in. upwards and suitable for screening of ores, sand, gravel, etc.

Hunting Geophysics, Ltd., of 6, Elstree Way, Boreham Wood, Herts., in an illustrated brochure entitled "Exploration," indicate the scope of modern methods of geophysical survey, referring particularly to airborne techniques and their correlation with field and laboratory work.

Dallow Lambert and Co., Ltd., of Thurmaston, Leicester, in a recently issued leaflet, give a number of illustrations of their dry-tube dust filter installations. A more recent publication gives particulars of the company's wet deduster series, the principles of operation of which are described and illustrated together with examples of their applications.

Renold Chains, Ltd., of Wythenshawe, Manchester, in a new booklet illustrate the range of their products which covers simple, duplex, and triplex chains and wheels for power transmission and also others for mechanical handling purposes. Various chain mechanisms are included as well as cases and accessories and tools. A number of couplings and clutches are also shown.

Greenbat Battery Locomotive



Victor Products (Wallsend), Ltd., of Wallsend-on-Tyne, issue a leaflet describing their tungsten carbide tipped percussive drill bits. These are available in both single chisel and cross-bit types, the former in two diameters ($1\frac{5}{8}$ in. and $1\frac{11}{16}$ in.) and the latter is five sizes from $1\frac{1}{4}$ in. to $1\frac{3}{4}$ in., although other dimensions can be supplied.

Frederick Parker, Ltd., of Catherine Street, Leicester, put out some notes on their Loadascreen. This is a portable conveyor with attached vibrating screen at the discharge head and suitable for sand and gravel handling. The prototype has recently been tested in a Leicestershire quarry and is being marketed with a 40-ft. boom and 18-in. belt. A range of eight sizes is planned.

Westinghouse Brake and Signal Co., Ltd., of 82, York Way, King's Cross, London, N. 1, have issued a further series of illustrated pamphlets on their mining equipment. These cover: Point operation, the model 10 and model 21 tub retarders, mine car loading, the in-line valve, double-sided retarders, the propelling unit for tubs, and mine car traffic control at Ollerton Colliery and re-organization at Easington Colliery.

Imperial Chemical Industries, Ltd., of Imperial Chemical House, Millbank, London, S.W. 1, have produced a further new booklet. This is devoted to the sale, storage, and conveyance of explosives by road and sets out the necessary safety requirements and precautions. There are a series of plates giving architectural details of various types of buildings suitable for the purpose and other useful information.

Sharpe Instruments, Ltd., of 6080, Yonge Street, Willowdale, Toronto, publish three leaflets describing their prospecting instruments. These are the model VP6 ground voltameter for ground prospecting, the A3 for airborne and ground reconnaissance, and the SE200 electromagnetic instrument for vertical or horizontal configuration. Each is well illustrated and contains concise details and methods of use.

Rapid Magnetic Machines, Ltd., of Lombard Street, Birmingham are now manufacturing deep field circular lifting magnets of a much deeper construction than conventional design, the makers state, and these give up to 100% greater lift, depending on the nature of the load. A typical magnet is operating in the slag industry and lifting up to 3-ton lumps of iron-bearing slag or skull cracker balls at anything up to nine tons weight.

Longworth Scientific Instruments, Co., Ltd., of Abingdon, Berks., have produced a leaflet describing their isokinetic sampling apparatus. They point out that this is now in production after development by the British Iron and Steel Research Association and is for the collection and estimation of dust and fume samples. It comprises five linked units—namely, a sampling probe, a filter unit-cooling coil, pump, and measuring instrument. In addition a combined pitot tube and pyrometer is provided for measuring gas velocities and temperatures.

G. A. Harvey and Co. (London), Ltd., of Greenwich Metal Works, London, S.E. 7, announce that Mr. H. E. Cooper, who joined the company in 1945 as consulting engineer to the board of management and was appointed to the board of the company in the following year has been made managing director. The same announcement refers to the impending retirement as sales director of Mr. P. T. Bliss after 50 year's service with the company. He is succeeded as sales director by Mr. I. A. Marriott.

Sandvikens Jernverks Aktiebolag, of Sandviken, Sweden, have produced a leaflet which refers to the founding of the company in 1862 for the exploitation of the Bessemer steel-making process. The booklet then goes on to describe briefly the products for which the company has become renowned—strip, wire, tubes, conveyor bands, springs, and miscellaneous items, and, most recently, the Coromant range of tungsten carbide tools including rock-drill steels which are marketed by the **Atlas Copco** group.

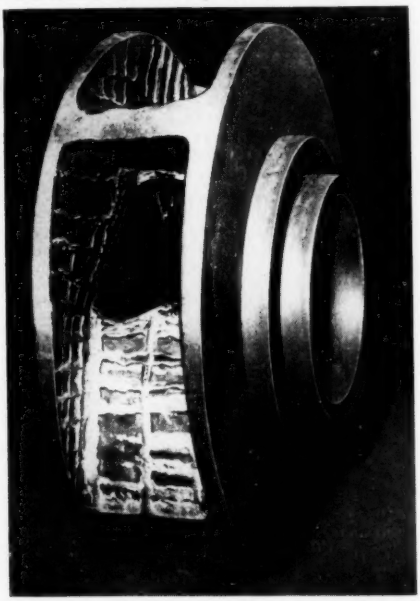
Greenwood and Batley, Ltd., of Leeds, make available a catalogue describing the more recent addition to their range of battery locomotives to which reference was made in the June issue in connexion with their exhibit at the Mechanical Handling Exhibition. This is the 14-ton unit which is supplied with either a central control cab or with double-end control, as illustrated here. A brief specification is: Drawbar pull, 4,000 lb.; level speed, 8 m.p.h.; maximum pull, 7,000 lb.; gauge, 24 in. to 42 in.; motors, two 45 h.p.

Hilger and Watts, Ltd., of 98, St. Pancras Way, London, N.W. 1, make some particulars available regarding the use of Hilger medium direct-readers for the automatic analysis of iron and steel and point out that recent research has demonstrated that they can be used successfully to determine (*a*) silicon, manganese, and the principal residual elements in mild steel, (*b*) silicon and manganese in cast iron, and (*c*) certain elements in low alloy steels if the concentration of the main alloying constituents is not too high. Typical results obtained are given.

Quasi-Arc, Ltd., of Bilston, Staffs., are now manufacturing Mirrospeed electrodes. They are said to be easy to use and a "touch" technique is preferred so that even a moderately skilled welder

can achieve sound results. The electrodes are suitable for production work in mild steel where high output and good weld profile are of major importance since their characteristics include smooth running, quiet arc, and fluid yet easily-controlled slag. Easy slag detachability enables deslagging to be kept to a minimum. Mirrospeed are manufactured in sizes ranging from 12 s.w.g. to 4 s.w.g. inclusive.

Deloro Stellite, Ltd., of Highlands Road, Shirley, Solihull, Warwicks., refer in some recently issued notes to the problem of wear on gravel pumps and the experience of a sand and gravel company near London. The addition of Delchrome by arc welding, as shown in the accompanying illustration, has



greatly reduced wear. Two 6-in. impellers are in use and changed over weekly. While one is in use the other is being faced. The impellers would last longer but a test over 70,000 cu. yd. has shown that regular hardfacing provides maximum pumping efficiency at lowest cost. The photograph is reproduced by permission of St. Albans Sand and Gravel Co., Ltd., of London Colney.

British Timken, Ltd., of Duston, Northants., received the Grand Prix at the Brussels Exhibition for the best precision mechanics exhibit which appeared in the British Industries Pavilion. The current issue of the company's house magazine—*Timken Times and F.B.C. Bulletin* is an 84-page fully-illustrated number and is devoted in part to a report on their second Overseas Sales Conference for which their representatives assembled from all parts of the world. The rest of the issue is a supplement devoted to that now well-known annual social function the Timken Show.

Wild-Barfield Electric Furnaces, Ltd., of Watford, announce that the NRC Type 912 vacuum fusion gas analyser for the determination of oxygen, nitrogen, and hydrogen in metals is now available as a British-built unit. Over 200 of these equipments are in operation. Because of the ability of the type 912 to analyse very small samples only a 3·5-kW induction heating generator is employed. A demonstration equipment has been installed at Elecfurn Works, Watford, where by prior appointment prospective customers may witness a complete analysis.

Dunlop Rubber Co., Ltd., of 10–12 King Street, St. James's, London, S.W. 1, announce that they have added to their new " Star " range of conveyor belting a super belt known as " Star Fort " which has a tensile strength per ply in excess of anything previously known in belting and which will have many applications in long hauls and high lifts. Belts in this range, having a strength in the region of 20,000 lb. per inch width, embody a fabric which is heat stable and proof against microbicidal. Another development in belting announced concerns a new construction for which a patent has been applied. This ensures the correct degree of lateral flexibility in a belt of any ply rating or width.

E. J. Longyear Co., of 76, South Eighth Street, Minneapolis, Minnesota, state that John F. Hoffmeister has been appointed chief engineer of the company. As head of the engineering department, he will direct all mechanical engineering activities of the company, which is engaged in the manufacture of diamond core drills and related equipment, geological consulting, and diamond drilling on a world-wide basis. A newly published eight-page booklet gives information on the uses of diamond core drills, describes the function of the major parts, and illustrates the various types of drills and drilling rigs available. Operation of the working parts of a high capacity drill is also described.

Sheepbridge Equipment, Ltd., of Chesterfield, Derby., have just completed a headgear for the

Silverhill Colliery at Teversal, Notts., of the N.C.B. The new installation shown here was erected over existing headgear and buildings, the dismantling of the old gear and its replacement by the new structure being completed during the fortnight's shut-down of the pit.

The headgear, 70 ft. high, is fitted with over-wind safety-catch gear which has an automatic lubricating system. The boss of the two pulley wheels is made up of two mild-steel forgings, to which are welded plates for holding the spokes, these being made of 3 by 3 by ½ mild-steel angles. The rims are of mild-steel segments and mild-steel rings are shrunk on the bosses to ensure tightness. The total weight of each pulley is 5½ tons.

Metropolitan-Vickers Electrical Co., Ltd., of Trafford Park, Manchester, announce that a recent order placed by the N.C.B. is for a flameproof battery locomotive for Markham Colliery, near Chesterfield. The locomotive, which will be used chiefly for hauling manriding carriages and material trains over the 2-ft. gauge lines, involving gradients of 1 in 21·2, derives its power from a lead-acid battery of 100 cells (415 Ah. capacity at the five-hour rate of discharge) which is divided into two equal sections housed in identical steel containers. It is driven by two series-wound traction motors specially designed for underground mining work; each motor has a one-hour rating of 46·5 h.p. at 200 amps., 200 volts, 610 r.p.m.

Atlas Copco AB, of Stockholm, included in the exhibit by their associated company to which reference is made later in these notes an example of their vertical air leg as illustrated. The tool is designed to fill the gap existing in bench drilling equipment between hand-held machines and wagon drills. It consists of three main parts—feeder, anchor bolt, and rock-drill. The latter is raised and lowered by compressed air which makes drill steel changes easier and minimizes operator fatigue. On a construction site in Sweden one man in one shift drilled to a depth of 735 ft. using this machine with an Atlas Copco "Lion" drill. This figure is possibly a world record for bench drilling with rock-drills in this weight class. Drill-steel changes can be achieved in about 30 seconds, while the time taken for pulling out, moving, and fitting the equipment in a new anchor bolt-hole is only about 2 minutes.

General Electric Co., of 150, East 42nd Street, New York in a recent statement from Erie, Pennsylvania, refer to a major step in the modernization of a South American mining operation made when 13 of the company's locomotives went into service on a railway operated by the Anglo-Lautaro Corporation in northern Chile. Eleven of the new units are diesel-electric and two are straight electric. Eight of the diesel-electrics are 73-ton units of 720 h.p. and three are model U12C universal locomotives of 1,320 h.p. The addition of the new locomotives is another stage of a programme begun 30 years ago, when Anglo-Lautaro purchased 28 30-ton G-E electrics in 1927 for work in the mines, while seven 67-ton electric locomotives were placed in service in 1928 for mainline haulage. In 1930 seven G-E trolley locomotives were purchased for use in the mines.

Allis-Chalmers Manufacturing Co., of Milwaukee, Wisconsin, make available some notes on their continuous compacting process, for upgrading fine chemical salts, to be installed at a potash mine in eastern France. The process can be applied, it is stated, to all inorganic salts as well as other materials where particle size, density, and solubility rate need close control and essentially consists of compacting fine particles between two rolls under extremely high mechanical pressures to produce a continuous sheet of material, breaking the sheet with a flake breaker, granulating the pieces between two corrugated rolls operated at differential speeds, and screening the product for desired size. In the initial step the potash ore is ground in Allis-Chalmers rod-mills. From a 4 by 10 mm. feed it is reduced and screened to 90% passing 0·8 mm. to prepare it for treatment by cold flotation process. The potassium chloride floats in the cells as the sodium chloride sinks. The potassium chloride is then dewatered and dried. The fine particle sizes are upgraded by compacting.

Carpco Manufacturing Co., of Jacksonville, Florida, in a recent announcement state that they have greatly intensified their potential world-wide distribution of plants and equipment by licensing the Joy Manufacturing Co., of Pittsburgh, as manufacturer and distributor of high-tension separators for the iron-ore industry. At the same time Carpco Research and Engineering, Inc.—an associated company—has been working on a joint project with the Kewanee Oil Co. of Philadelphia in the development of a high-tension process for the clarification and dehydration of crude oil and other types of emulsions. It is suggested that these two associations will greatly strengthen Carpco's unique position in the fields of mineral and petroleum beneficiation. Carpco also assert that they will still strive to maintain their position as leader in the field of rare and heavy mineral beneficiation and will continue to supply the same services of engineering, plant design, equipment, maintenance parts, and trouble shooting "to all its old customers around the world to whom it owes its beginning and rapid growth."

Public Works and Municipal Services Congress and Exhibition

The Public Works and Municipal Services Congress and Exhibition, which is held every two years, took place at Olympia from November 10 to 15. A number of the manufacturers represented are also known as makers of mining plant and machinery and some notes follow on items likely to interest readers of the MAGAZINE. Further notes will appear in subsequent issues.

Atlas Copco (Great Britain), Ltd., of Wembley, Middx., showed products not previously exhibited—namely, the vertical air leg (on which a note appears elsewhere), the Tiger rock-drill, on which a later note will be given, and the T2G loader-dumper powered by compressed air. This machine was developed originally at the Montevecchio Mine, Sardinia, for the purpose of handling broken ore in the overhand stopes. It consists essentially of an overthrowing type of shovel loader mounted on a rubber-tyred dump wagon with a 3½-cu. ft. bucket operated by a vane-type motor.

Caterpillar Tractor Co., Ltd., of Glasgow, had as their main exhibit the Caterpillar D8 crawler tractor, equipped with a No. 8S bulldozer and hydraulic control and Hyster D8D towing winch. The tractor has a 225-h.p. turbocharged six-cylinder diesel engine and the machine, weighing 46,734 lb., has a ground clearance of 19⅞ in. There are six forward and six reverse speeds. Also exhibited were: A D7 crawler tractor, a DW21 tractor and No. 470 scraper with hydraulically controlled No. 8A ripper, and a rear dump wagon.

Hadfields, Ltd., of Sheffield, who were represented at the exhibition for the first time, included on their stand a 6-cu. yd. Esco triple tapered dragline bucket which was the main feature. It is of all-welded construction with lip and rigging cast in "Era" manganese steel and other cast parts in Esco 12M alloy steel. Special features include triple tapered design for faster filling, cleaner dumping, and longer bucket life. An Esco medium duty bucket of ¾ cu. yd. equipped with cast manganese-steel drag and hoist chains was also shown. As an example of their crushing machinery they exhibited a 36 in. by 24 in. roller-bearing jaw-crusher and a scale model of a larger machine. In addition there were miscellaneous castings for crushing and earth-moving equipment.

Holman Bros., Ltd., of Camborne, Cornwall, had assembled for the first time at any exhibition equipment from all the companies of the Group—*i.e.*, from Holman Bros., Ltd., from the Climax Rock Drill and Engineering Works, Ltd., Goodyear Pumps, Ltd., the Dustuctor Co., Ltd., and Maxam Power, Ltd. The chief item in the exhibit was the Rotair air-compressor, which is referred to under Trade Notes in this issue. Also shown were reciprocating-type compressors, including the Climax F80 AX (315 c.f.m.). A wide range of Holman and Climax rock-drills were displayed and also the Dryductor system for dust trapping when drilling dry. Among drilling accessories were airlegs and stoperlegs and the latest "Junior" Holbits (tungsten-carbide tipped). Also shown for the first time were: A Climax wagonette mounting a Holman Silver Three rock-drill, a self-propelled hydraulic wagon drill with drifter in 10-ft. cradle, and a self-contained tractor combination incorporating a front-mounted Holman F.M.13 compressor and a rear-mounted vole drill.

Ingersoll-Rand Co., Ltd., of 165, Queen Victoria Street, London, E.C. 4, were showing a new air winch suitable for all types of lifting, hoisting, and dragging jobs, having a capacity of 2,000 lb. and an average speed at rated load of 124 ft. per minute. Portable compressors shown included a model for 120 c.f.m. and 100 p.s.i. incorporating a two-stage air-cooled unit with Ford diesel engine driven through a hand-operated segmental type clutch. In addition to another type of air winch other pneumatic machines exhibited included a range of rock-drills and accessories such as the Jackleg and steels and bits.

Marshall Sons and Co., Ltd., of Gainsborough, Lincs., and **John Fowler and Co. (Leeds), Ltd.,** of Leeds, were associated with exhibits on two stands, which included several examples of tractors. Of chief importance is the new Fowler Challenger 33 crawler tractor fitted with Marshall hydraulic angle-dozer and cable control unit and a Leyland 125-b.h.p. diesel engine, which was shown for the first time.

Michigan (Great Britain), Ltd., of 3–5, Charles II Street, St. James's Square, London, S.W. 1, introduced three new tractors, one of which was publicly shown for the first time in this country. This is 275A which is powered by a 265-h.p. diesel, has a capacity of 22,000 lb., and is available with a 4-cu. yd. heavy-duty bucket. Also from United Kingdom production was the new model 85A tractor shovel—capacity 9,000 lb.—carrying optional bucket sizes from 1¾ cu. yd. up to 2½ cu. yd. The power unit is a Leyland diesel developing 92 h.p. at 2,200 r.p.m. The third item was the giant 380 tractor dozer brought direct to the exhibition from sites in the Midlands. Powered by a Cummins 375-h.p. diesel the 380 is described as the largest wheeled tractor dozer available in Britain. Front-end equipment includes a 14-ft. blade with "built in" pusher attachment for heavy duty and a 20-ft. blade for light materials.

Motor Rail, Ltd., of Simplex Works, Bedford, introduced a new dumper. Designated MR-4 it has these features: A level-loaded capacity of 3¼ cu. yd. and a heaped capacity of 4 cu. yd. with a full loading of 5 tons; fully reversible steering; the driver always faces the direction in which he is moving; construction that will withstand the roughest site conditions. A Dorman 2LB diesel engine is the power unit the drive to the fully-floating driving axle being through a constant-mesh gearbox and a 17½-in. diameter single dry-plate clutch. There are three forward and reverse speeds. Another exhibit was the newly-designed 30-h.p. Simplex diesel locomotive which also employs the Dorman 2LB engine and is said to be the most compact vehicle yet built by the company.

Ruston-Bucyrus, Ltd., of Lincoln, were showing the 22-RB transit machine which is a crane/excavator designed to give the user maximum capacity and mobility for diversified jobs coming within its category. As a lifting crane it has a capacity of 22 tons and was shown equipped with a 70-ft. boom and a 20-ft. offset jib. The maximum boom length is 80 ft. with a 30-ft. jib and the boom itself is of the pin-connected self-erecting type and may be folded into a carrying position for travelling. The machine is mounted on a Foden six-wheel chassis provided with outriggers with screw-type jacks, full equipment, and powered by their FD6 engine of 126 h.p. As an excavator the machine has a capacity of ¾ cu. yd. and is fully convertible to shovel, drag-

shovel, dragline, and grabbing crane. The power unit on the superstructure is a Ruston type 6YDAN air-cooled diesel engine rated 66 h.p. at 1,275 r.p.m. Also shown were a cambered-boom dragshovel with a ¾-cu. yd. hoe-type dipper suitable for a 22-RB base machine either lorry or caterpillar mounted and a Bax dragline bucket of 7 cu. yd. capacity as supplied for open-cast mining.

Sheepbridge Equipment, Ltd., of Chesterfield, were displaying for the first time a new 20-in. roller-bearing tertiary gyratory crusher specially developed to produce fine granular material with a minimum of dust. Also on the stand was a standard type 19 Sheepbridge Kennedy secondary gyratory crusher. A typical example of the two-deck Sheepbridge Kennedy vibrating screens was also on view together with a standard Schaffer poidometer for automatic control and record of material handled.

Wilkinson Rubber Linatex, Ltd., of Camberley, Surrey, were displaying for the first time in this country a working installation demonstrating the Linatex sand separation system. The plant shown was being fed with unwashed sand and its extreme flexibility and self-compensating characteristics when handling "dirty" material and intermittent feed were specially demonstrated. Key units are the well-known Linatex pump, an entirely new Linatex separator with matching units, including a feed regulating sump, tower and bin, valves, and pipework. The plant will, it is claimed, deliver to bins or stockpiles a clean, dewatered sand or similar material automatically. Complete standard units are available in four sizes.

RECENT PATENTS PUBLISHED

☛A copy of the specification of the patents mentioned in this column can be obtained by sending 3s 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

36,860 of 1955 (803,264). UNITED KINGDOM ATOMIC ENERGY AUTHORITY. Extraction of metals from aqueous solution.

4,115 of 1956 (802,376). DEUTSCHE GOLD- UND SILBER SCHEIDEANSTALT VORM. ROESSLER. Process for the production of metals by reduction of their compounds.

11,696 of 1956 (802,336). SOC. DES BLANCS DE ZINC DE LA MEDITERRANEE. Method of producing titanium concentrates by reduction smelting of titanium-bearing iron ores.

18,137 of 1956 (802,452). COMMISSARIAT A L'ENERGIE ATOMIQUE. Method of recovering uranium from ores containing it.

18,176 of 1956 (802,095). SOC. D'ELECTRO-CHIMIE, D'ELECTRO-METALLURGIE ET DES ACIERIES ELECTRIQUES D'UGINE. Production of titaniferous concentrates and iron.

26,658 of 1956 (802,543). AMERICAN SMELTING AND REFINING CO. Removal of silicon values from an aqueous non-acid solution of germanium and silicon values.

38,601 of 1956 (803,008). TITAN CO. A.S. Reduction of iron ores.

1,940 of 1957 (802,259). KLÖCKNER-HUMBOLDT-DEUTZ A.-G. Device for the sink-float separation of minerals.

19,339 of 1957 (803,256). PECHINEY CO. DE PRODUITS CHIMIQUES ET ELECTROMETALLURGIQUES. Production of manganese.

21,248 of 1957 (803,356). NATIONAL LEAD CO. Method for producing zirconium metal.

22,244 of 1957 (802,470). UNITED KINGDOM ATOMIC ENERGY AUTHORITY. Production of beryllium.

NEW BOOKS, PAMPHLETS, ETC.

☛Publications referred to under this heading can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C. 2.

Geological Structures and Maps: A Course in Interpretation with Applications for Civil and Mining Engineers. By A. ROBERTS. Paper backs, 92 pages, illustrated. Price 12s. 6d. London: Cleaver-Hume Press, Ltd.

Support of Roadheads in Advance of Rippings: Ministry of Power Safety Pamphlet No. 27. Paper covers, 20 pages, illustrated. Price 1s. London: H.M. Stationery Office.

Memorandum on the Stratified Ironstone, Shale, and Fireclay Mines (Explosives) Regulations, 1956. Paper covers, 22 pages. Price 1s. 3d. London: H.M. Stationery Office.

National Coal Board: Statistics Relating to Mechanized Output (First Quarter, 1958). Paper folio. N.C.B. Inform. Bull. No. 58/200.

A Survey of the Iron Ore Industry in Canada During 1957. Canad. Mineral Information Bulletin MR27. By T. H. JANES and R. B. ELVER. Paper covers, 116 pages, illustrated. Price 25 cents. Ottawa: Dept. of Mines and Technical Surveys.

Metallurgical Works in Canada: Primary Iron and Steel. Canad. Mineral Operators List I, Part 1. Paper covers, 36 pages. Price 25 cents. Ottawa: Dept. of Mines and Technical Surveys.

British Columbia: Minister of Mines Annual Report, 1957. Paper covers, 176 pages. Victoria, B.C.: Department of Mines.

Department of Mines, South Africa: Waterberg Coalfield—Records of Boreholes 101 to 143 drilled for the Department, with notes by J. F. Cillié, and the Fuel Research Institute. Geological Series Bulletin No. 23. Paper covers, 276 pages, illustrated. Price 10s. Pretoria: Government Printer.

The Chromiferous Ultrabasic Rocks of Eastern Sierra Leone. Overseas Geology and Mineral Resources Bulletin Supplement No. 3. By K. C. DUNHAM and others. Paper covers, 44 pages, illustrated. Price 4s. London: H.M. Stationery Office.

Nigeria: Records of the Geological Survey, 1955. Paper covers, 70 pages, illustrated, with maps. Price 7s. 6d. Lagos: Federal Government Printer.

Tanganyika: Geological Survey Department Report, 1957. Paper covers, 18 pages. Price Shs. 2/50. Dar es Salaam: Government Printer.

Nigeria: Mines Department Report for the Year ended March 31, 1957. Paper covers, 48 pages. Price 9d. Lagos: Federal Government Printer.

Selected Annotated Bibliography of the Geology of Uraniferous and Radioactive Bituminous Substances, Exclusive of Coals, in the United States: *U.S. Geol. Surv. Bull.* 1059-D. By H. N. JONES. Paper covers, pp. 177–203, with map. Price 45 cents. Washington: Superintendent of Documents.

Selected Index to Current Literature

This section of the Mining Digest is intended to provide a systematic classification of a wide range of articles appearing in the contemporary technical Press, grouped under heads likely to appeal to the specialist.

* Article in the present issue of the MAGAZINE.

† Article digested in the MAGAZINE.

Economics

Development, Canada : *B.C., Northern.* Mineral Development and Transportation in Northern British Columbia. H. SARGENT, N. D. MCKECHNIE, *Western Miner*, Oct., 1958.

Production, Canada : *Iron-Ore, Survey.* A Survey of the Iron-Ore Industry in Canada During 1957. T. H. JANES, R. B. ELVER, Canad. Mineral Information Bulletin MR 27.

Production, Canada : *Mineral, Yukon.* The Mining Industry in Yukon. G. ROBERTSON, *Western Miner*, Oct., 1958.

Production, Jamaica : *Bauxite, Review.* Jamaican Bauxite in the West Indies Economy. SMITH BRACEWELL, *Min. Engg.*, Oct., 1958.

Production, United Kingdom : *China-Clay, Cornwall.* Goonvean China-Clay Pit. *Mine, Quarry Eng.*, Nov., 1958.

†**Production, World :** *Uranium, Review.* World Uranium Production. *Western Miner*, Sept., 1958.

Resources, Canada : *Iron, Steel.* Iron Ore and Other Raw-Material Sources for a Primary Iron and Steel Industry in Western Canada. T. H. JANES, *Canad. Min. Metall. Bull.*, Sept., 1958.

†**Resources, Canada :** *Mineral, Saskatchewan.* The Operations of the Hudson Bay Mining and Smelting Co., Ltd. *Precambrian*, Sept., 1958.

Resources, Mexico : *Lead-Zinc, Zacatecas.* New Four-Mile Tunnel Adds New Life to Penoles' Avalos Lead-Zinc Mine. *Engg. Min. J.*, Oct., 1958.

Resources, Sahara : *Survey, Statistical.* Évaluation des Perspectives Économiques de la Recherche Minière sur de Grands Espaces : Application au Sahara Algérien. M. ALLAIS, *Bull. Sci. Econ. B.R.M.A.*, Série 1957.

Resources, United States : *Copper, Arizona.* Exploration Extends Magma's Future. R. WEBSTER, *Min. Engg.*, Oct., 1958.

Geology

Ages, Rock : *Determinations, California.* Age Determination of Some Granitic Rocks in California by the Potassium-Argon Method. G. H. CURTIS and others, Calif. Div. Mines Special Report 54.

Economic, Africa : *Chrome, Sierra Leone.* The Chromiferous Ultrabasic Rocks of Eastern Sierra Leone. K. C. DUNHAM and others, Overseas Geol. Min. Res. Supplement Series No. 3.

Economic, Africa : *Gold, Tanganyika.* Geology and Gold Deposits of the Ruvu River Area. B. N. TEMPERLEY, Tang. Geol. Surv. Short Paper No. 24.

Economic, Africa : *Sands, South.* Ilmenite-Bearing Sand Along the West Coast in the Vanrhynsdorp District. C. B. COETZEE, *S. Afr. Geol. Surv. Bull.* 25.

Economic, United States : *Fluorspar, Western.* Geologic Characteristics of Fluorspar Deposits in the Western United States. W. C. PETERS, *Econ. Geol.*, Sept.–Oct., 1958.

Economic, United States : *Uranium, Guides.* Evaluation of Uranium Ore Guides, Monument Valley, Arizona and Utah. C. G. EVENSON, I. B. GRAY, *Econ. Geol.*, Sept.–Oct., 1958.

***Mineralogy, Determinative :** *System, New.* A System of Ore Mineral Identification. S. H. U. BOWIE, K. TAYLOR, THE MINING MAGAZINE, Nov., 1958.

Regional, Canada : *Newfoundland, North-East.* Geology of the Newman Sound Map Area. S. E. JENNESS, Newfoundland Dept. Min. Res. Geol. Surv. Report No. 12.

Sulphides, Genesis : *Study, United States.* Temperatures and Depth of Formation of Sulphide Ore Deposits at Gilman, Colorado. T. G. LOVERING, *Econ. Geol.*, Sept.–Oct., 1958.

Survey, Geochemical : *Determination, Nickel.* Modified Field Test for the Determination of Small Amounts of Nickel in Soils and Rocks. R. E. STANTON, J. A. COOPE, *Bull. Instn. Min. Metall.*, Oct., 1958.

Survey, Geophysics : *Anomalies, Magnetic.* Magnetic-Doublet Theory in the Analysis of Total-Intensity Anomalies. R. G. HENDERSON, I. ZIETZ, *U.S. Geol. Surv. Bull.* 1052-D.

Metallurgy

***Hydrometallurgy, Copper :** *Use, Bacteria.* Use of Bacteria in Leaching. Ore-Dressing Notes, THE MINING MAGAZINE, Nov., 1958.

Iron, Reduction : *Process, Fluid-Bed.* Reduction of Iron Ore by Carbon Monoxide : The Stelling Fluidized-Bed Process. *Iron, Coal Tr. Rev.*, Nov. 7, 1958.

Iron, Steel : *Progress, Review.* Recent Development in Iron Smelting and Steel-Making Processes. W. M. ARMSTRONG, *Canad. Min. Metall. Bull.*, Sept., 1958.

***Lithium, Recovery :** *Treatment, Ore.* Australian Spodumene. Ore-Dressing Notes, THE MINING MAGAZINE, Nov., 1958.

Ores, Uranium : *Control, Grade.* How Anaconda Automatically Assays Jackpile U_3O_8 Ore for Grade Control. *Min. World* (San Francisco), Oct., 1958.

Processing, Potash : *Tool, Control.* The Geiger Counter as a Control Tool in Processing Potassium-Bearing Ores. W. C. KNOPF, G. SAMSEL, *Min. Engg.*, Oct., 1958.

Sampling, Ore : *Practice, Uranium.* Good Practice in Uranium Ore Sampling. G. C. RITTER, *Min. Engg.*, Oct., 1958.

Smelting, Manganese : *Research, Canada.* Experimental Electric Smelting of Manganese Ores—Part I. R. A. CAMPBELL and others, Canad. Mines Branch Research Report R 19.

Machines, Materials

Engines, Diesel : *Safety, Underground.* Safety with Diesels at Ojibway Rock Salt Mine. M. F. O'Day, *Canad. Min. J.*, Sept., 1958.

Explosives, Design : *Test, Formulation.* The Design of Explosives. G. R. Phare, J. F. C. Dixon, *Canad. Min. Metall. Bull.*, Sept., 1958.

Roasting, FluoSolids : *Sulphides, Japan.* FluoSolids Roasting of Dowa's Yanahara Sulphides. H. Kurushima, R. M. Foley, *Min. Engg.*, Oct., 1958.

***Winder, Friction :** *Coal, United Kingdom.* Multi-Rope Friction Winder. The Mining Magazine, Nov., 1958.

Mining

Breaking, Drilling : *Long-Hole, Australia.* Broken Hill Tries Long-Hole Drilling. *Engg. Min. J.*, Oct., 1958.

Breaking, Drilling : *Performance, Percussive.* Some Further Factors Affecting Percussive Drilling Performance and Their Influence on the Size Distribution of the Cuttings. F. W. Inett, *Bull. Instn. Min. Metall.*, Nov., 1958.

Bulkhead, Underground : *Test, High-Pressure.* Tests on an Experimental Underground Bulkhead for High Pressures. W. S. Garrett, L. T. Campbell Pitt, *J. S. Afr. Inst. Min. Metall.*, Oct., 1958.

Control, Ore : *Uranium, United States.* Blending Control at Cord Mine. S. E. Craig, *Min. Engg.*, Oct., 1958.

Control, Ore : *Uranium, United States.* Jackpile Uses Extensive Blasthole Sampling. R. B. Schlosser, *Min. Engg.*, Oct., 1958.

Control, Ore : *Uranium, United States.* Lucky Mc. Employs Assays, Careful Open-Pit Slices. K. G. Wallace, *Min. Engg.*, Oct., 1958.

Driving, Support : *Coal, United Kingdom.* Support of Roadheads in Advance of Rippings. Ministry of Power Safety Pamphlet No. 27.

Equipment, Diesel : *Safety, Underground.* Safe Use of Diesel Equipment in Underground Metal Mines. J. C. Holtz, *Canad. Min. J.*, Sept., 1958.

General, Sweden : *Sulphides, Northern.* Mining Sulphide Ores in Northern Sweden—3. F. Kia, *Mine, Quarry Eng.*, Nov., 1958.

Handling, Haulage : *Costs, United States.* Bagdad Reports Haulage Costs. J. B. Huttl, *Engg. Min. J.*, Oct., 1958.

Hazard, Fire : *Control, Foam.* Studies with High-Expansion Foams for Controlling Experimental Coal-Mine Fires. I. Hartmann and others, *Rep. Inv. U.S. Bur. Min.* 5419.

Hygiene, Lighting : *Tests, Meter.* The Application of Visibility Meters to the Assessment of Adequacy in Mine Lighting. A. Roberts, D. F. Gibson, *Trans. Instn. Min. Eng.*, Nov., 1958.

Hygiene, Ventilation : *Efficiency, Review.* Mine Ventilation and Efficiency. B. J. R. Botha, J. A. Northcott, *J. S. Afr. Inst. Min. Metall.*, Oct., 1958.

Hygiene, Ventilation : *Flow, Air.* A Tracer Gas Technique for the Measurement of Air Flow in Headings. J. Higgins, S. E. H. Shuttleworth, *Coll. Engg.*, Nov., 1958.

†**Hygiene, Ventilation :** *Gold, South Africa.* The Ventilation of Gold Mines in South Africa. M. Barcza, *J. S. Afr. Inst. Min. Metall.*, Aug., 1958.

Labour, Rhodesia : *Efficiency, Review.* Progress Towards Improved Efficiency in Mines of the Lonrho Group—Southern Rhodesia. T. D. Salisbury, *J. S. Afr. Inst. Min. Metall.*, Oct., 1958.

†**Open-Pit, Blasting :** *Iron, Canada.* Pit Operations at the Marmoraton Mine, Hastings County, Ontario. C. A. Lorenson, J. S. K. McChesney, *Canad. Min. Metall. Bull.*, Sept., 1958.

Pressure, Rock : *Measurement, Review.* How to Measure Rock Pressures. K. P. Gupta, *Engg. Min. J.*, Oct., 1958.

Pressure, Rock : *Tests, Compression.* Some Elastic Properties of Rocks under Uniaxial and Triaxial Compression Tests. R. Segal, K.G.F. Min. Metall. Soc. Bull. No. 88.

Safety, Underground : *Code, Sweden.* Book of Standard Practices for Mines of the Mining Association of Sweden. *Canad. Min. J.*, Sept., 1958.

***Sinking, Shaft :** *Coal, United Kingdom.* Rapid Sinking in Coal Measures. The Mining Magazine, Nov., 1958.

Sinking, Shaft : *Gold, South Africa.* Sinking No. 2 Shaft, Harmony Gold Mining Co., Ltd. S. C. Newman, *J. S. Afr. Inst. Min. Metall.*, Sept., 1958.

Support, Filling : *Use, Sands.* Preparation and Handling of Sand for Hydraulic Stope Filling. C. V. Johnson, H. J. Gisler, *Deco-Trefoil*, Sept.–Oct., 1958.

Support, Roof : *Bolting, Rock.* Rock Bolting at McIntyre Porcupine Mines. A. A. Adamson, *Canad. Min. J.*, Sept., 1958.

Support, Roof : *Bolting, Rock.* The Why of Rock Bolting. A. V. Corbett, *Canad. Min. J.*, Sept., 1958.

Ore-Dressing

Beneficiation, Potash : *Separation, Electrostatic.* Application of Electrostatics to Potash Beneficiation. I. M. LeBaron, W. C. Knopf, *Min. Engg.*, Oct., 1958.

Concentration, Delicate : *Micropanner, Use.* The Micropanner—an Apparatus for the Gravity Concentration of Small Quantities of Materials. L. D. Muller, *Bull. Instn. Min. Metall.*, Oct., 1958.

Flotation, Differential : *Review, Northern Rhodesia.* How Chibuluma Floats Copper-Cobalt. J. E. Harper, *Min. World* (San Francisco), Oct., 1958.

Gravity, Cyclone : *Refining, China-Clay.* The Hydrocyclone in the Refining of China Clay. T. R. Naylor, *Mine, Quarry Eng.*, Nov., 1958.

Separation, Electrostatic : *Review, United States.* Potash ; Pebble Phosphate ; Feldspar. *Min. Engg.*, Oct., 1958.

Sink-Float, Iron : *Taconite, United States.* DSM Screens in a Heavy-Media Cyclone Plant. W. R. Van Slyke and others, *Min. Engg.*, Oct., 1958.

Slurries, Movement : *Tanks, Aerator.* Measurement of Residence Time of Slurries in an Aerator Tank, using Radioactive Tracers. E. C. Gibson, G. C. Eichholz, Canad. Mines Branch Research Report R. 18.

ica. The
Barcza,

Progress
of the
T. D.
ct., 1958.
it Opera-
County,
Chesney,

How to
a, *Engg.*

Some
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G.F. Min.

Book of
g Associa-
958.
n. Rapid
Magazine,

Sinking
Ltd. S. C.
ept., 1958.
ration and
ing. C. V.
Sept.–Oct.,

Bolting at
on, *Canad.*

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Sept., 1958.

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neficiation.
Engg., Oct.,

, *Use*. The
avity Con-
ials. L. D.
1958.

thern Rho-
balt. J. E.
ct., 1958.

Clay. The
Clay. T. R.
8.

nited States.
Min. Engg.,

tates. DSM
nt. W. R.
t., 1958.

. Measure-
an Aerator
C. Gibson,
h Research